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## T H.E

## Religious Pbilofopher:

Or, the Right USE of
Contemplating the W. orks of the CREATOR:
I. In the wonderful Structure of Animal Bodies, and in particular, Man.
II. In the no lefs wonderful and wife Formation of the Elements, and their various Effects upon Animal and Vegetable Bodies. And, III. In the molt amazing Structure of the Heavens, with all its Furniture.
DESIGNED

For tbe Conviction of A THEISTS andINFIDELS.
V O L. I.

Throughout which, all the late Difcoveries in Anatomy, Philofophy, and Aftronomy, together with the various Experiments made ufe of to illuftrate the fame, are moft copioufly handled by that Learned Mathematician Dr. NIEUWENTYT.

## Clatmated from the IDintinal,

 By John Chamberlayne, $E \int q ; F . R$. S.To which is prefix'd,
A LETTER to the Translator, by the Reverend F. T. Defaguliers, M. A. F. R.S.
The Second Edition, Corrected.
Adorn'd with C U TS.
LONDON:

Printed by T. Wood for J.SenexinSalisbury-Court, and W.Taylor at the Ship in Paiter-Nofter-Row. 1719.



## TOTHE

## Mof Honourable <br> The Lord PARKER,

 Lord High-Chancellor of Great Britain, $\dagger$ \&c.My Lord;


OU gave an Intruder fokind a Reception at his firf Addrefs, that he is delighted with a Pretence to make you a fecond.

My firf Attempt was to prefent Your Lordhip with imperfect Copies, after my manner, of the Oria $2 \quad$ ginals
$\dagger$ Now one of the Lords Juffices.
ginals of feveral Famous French Pbilofophers, drawn by one of the beft Hands, that of the moft Ingenious Fontenelle; than whom Sir Godfrey Kneller, our Britifb Apelles, can hardly give an Object a more agreeable Likeņefs.

Now, my Lord, I am going to entertain You with a Picture of another kind, drawn by an honeft plain Dutch Pbilofopher; viz. a Sketch of Divine Wifdom and Providence, difplay'd in the Works of the Creation; whofe mafterly Strokes affect the Mind with a due Admiration for the Original, which he has fo well copied.

This Treatife of Philofophy the Author calls The Right UJe of the Contemplation of the W orld, \&zc. Thro' the Whole of which there runs fuch a Strain of unaffected Piety, that I doubt not but his good. Intentions,
tentions (even tho' he had not executed them fo well as he has done) mult have already procured him the inward Satisfaction of that Glorious Promife made to the Father of the Faithful, and, thro' him, to all Believers; I will be thy Sbield and exceeding great Reward.

My Lor D, I beg leave to call the Learned Phyfician, who is my Author, the Dutch R Ay or Derham, becaufe, like thofe two Englifh Philofophers, he has fo well prov'd the Wifdom, Power, and Goodness of G O D by the Atrongeft Arguments, Obfervations on Facts, and Demonftrations drawn from Experiments. It were to be wifh'd, that he had apply'd the Texts of Scripture, which he quotes, as properly as he has done his Philofophical Confiderations: but fince he has not fo well fucceeded in what may be call'd bis Divinity, I have left feveral of the Texts out
of this Tranflation ; but have retrench'd none of his Gloffes upon the particular Texts by him quoted, nor any of his Glorious Tautologies, in which he does fo often call upon Atheifts and Infidels; excepting where his Comment is wrong, or the Repetitions are too tedious, and, I hope, unneceffary, even for convincing of thofe unhappy Men to whom he addreffes himfelf; of whom it may be pronounced, that if they ftill perfint in the Denial of a God, after fo many irrefragable Arguments, drawn from the wonderful Structure of Humane Bodies, and all the orher Glorious W orks in the Univerfe, G o D will then barden their Hearts, and, like the Pharifees, they will not be perfwaded, tbo' one rofe from the Dead.

However, my Lor D, that I may not be thought to have acted rafhly in leaving out any thing of my Author's $s_{2}$

## The Dedication.

thor's, I have in this followed the Advice of feveral of my learned Friends, botb Pbilofophers and Divines, (to whom I communicated fome of thefe Sbeets in MS.) and if I only faid that your Lordhip approv'd of this defign'd Omiffion, the World wou'd be affur'd that I had confulted a Philofopher and a Divine: for as the Royal Society well know how Eminent your Lordfhip is in the firt of thefe Qualifications; fo many of the Clergy know, that a very able Prelate (now with GoD) and one mighty in Scripture-Learning, has openly profefs'd, that the Lord ParK ER is one of the greateft Divines in England.

And here, my Lord, it may not be amifs to fuggeft to You, how great a Trouble I have met with, in teaching my Author to fpeak Englill, who by his affecting to exprefs all his Technical Words or Terms

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vj Tbe Dedication.
of Ant in his pure veinacular Tongue, fuch as, for inftance, the Veins, Arteries, Muccles, Fibres, Nerves, and a thoufand other Anatomical, Phyfical, and even Matbematical Words too, has made me take Pains unknown to my indolent Temper thro' the whole Courfe of my Life till now; for I have not been able to procure any Help in this Cafe, neither from the Living nor the Dead. Indeed the Tables and Figures of my Author (which are very curious, and taken from the moft valuable Anatomints and Philofophers ) have been of good ufe to me, where there are proper References; but thofe were the only Affiftances I could procure here in England; fo that for the reft, I fhould have been forced to guefs at their Meaning, if my Learned Friend Mr. Sgravefande (Profeffor of Maibematics and Experimental Pbilofophy at Leyden) had not kindly interpreted to me thofe I could not unriddle:

The Dedication.
unriddle: for there is no more Analogy between my Author's Terms and the Latin or Greek commonly ufed by all other Philofophers, than there is between them and Hebrew or Arabic. My Lord, I don't fay this to praife myfelf or blame my Author, (who is rather to be commended for keeping up the Dignity of our Sifter-Tongue, Daughter of the Teutonic, and Granddaughter of the Gothic, the common Spring of all the Weftern Languages of Europe, from North almoft to South; and indeed we ourfelves are not to be juftify'd in lofing and obfoleting fo many of our moft fignificant Anglo-Saxon Words and Phrafes, as has been well oblerv'd before me by the Learned Mr. Baron Forte $\int$ cue,*) $\dagger$ but to leffen my own

* In his Ingenious Remarks upon the Lord Chancellor Fortefcue's Book, intituled, The Difference between an Abfolute and Limited Monarchy. Lond. Printed for E. Parker, I714. fince reprinted, with Additions.
$\dagger$ Now one of the Juftices of the King's Bench.


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own Fault, and more eafily to obtain your Lordfhip's Pardon, if the Difficulty of explaining thofe Terms has made me commit any Blunders.

I can't conclude, my Lord, without endeavouring to prevent your Lordfhip in Favour of my Author, on account of one good Quality; which for being fo rare and uncommon to moft Writers, makes it appear the more lovely and charming in my Eyes: it is, that altho' he paffionately endeavours throughout his whole Work (and repeats it fo often, almoft in every Section) to magnify the Wifdom and Goodnefs of God, and to point out his Great Ends and Purpofes in all the Works of the Creation; yet he is fuch an Enemy to Pious Frauds, and to the fupporting any of the Divine Attributes above-mention'd, by wrong?

## The Dedication. ix

or even doubtful and precarious Arguments, that he ufes none in confuting the Atheiff and Sceptic, but fuch as will bear even Mathematical Demonftration: This has made him a little too frict, it may be, in placing under the Clafs of Things unknown, the Motion of the Earth, and the reft of the Planets about the Sun, as that great Philofopher Dr. Clarke was pleas'd to obferve, when I communicated to him the Contents of this Work; That be could not but wonder extreamly, that in the 29th Contemplation, the Motion of the Earth Phould be placed among Uncertainties, after that the Parallax of the Annual Motion is $\mathrm{S}_{0}$ notorioufly apparent in the Phonomena of Comets, \&c.

But I forget, my Lord, that 1 am wafting thofe precious Minutes which your Lordhip employs fo ufe-
x The Dedication. ufefully in the Service of your King and Country : That you may long employ them fo, is the fincere and hearty Wifh of,
My Lord;

Weftm. May I3d
1718.

> Your LordJhip's

Moot obliged, faithful
and moft bumble Servant,

> J. CHAMBERLAYNE.


# A <br> LETTER <br> FROM 

The Reverend Mr.Defaguliers* to John Chamberlayne, Efq; relating to the following Treatife. S I R,
givik on Hi H AVE read your Tranflation of Dr. Nieuwentyt's excellent Treatife; and highly approve your Defign of Publifhing it, as it will be of great Service to Religion and Pbilofopby.

The Doctor's Reafon that be gives for writing his Book in Dutch (namely, that a great many Atheiftical Books having been written in that Language, he chofe to confute the Oppofers of a Providence in the fame) will be as powerful a Motive for the tran lating it into Englifh; fince we have not been behind-hand with our Neighbours in publifhing

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## A Letter from Mr. Defaguliers

ing the impious Conceptions and blafphemous Raillery of our Scoffers at Religion. If fuçh of them as had been able, had publifb'd their crude Notions in any of the learned Languages, their Books wou'd have needed no Anfwer, their Readers wou'd have defpifed them: But their Profelytes are gain'd among the Weak and Ignorant, or fuch conceited Debauchees as are glad to be fupply'd with Means of defending their Immoralitics, by attacking Religion with a fhew of Wit and Argument.

When an Atbeift has the Impudence to call himfelf a Philosophet, fome wellmeaning Perfons that have not much look'd into Nature, are apt to be prejudic'd againft the Study of it; as if the Pbilofophy and vain Dcceit, againft which the Apoftle has warn'd us, had been the Contemplation of the Works of the Creation: Whereas it was only the Sophiftry of the Schools, contriv'd to difguife Error, and defend the Syftem of the fuperftitious Heathen Divinity.

He that reads Nieupentyt will cafily fee that a Pbilofopher cannot be an Atbeift; and if it were true, that a Smattering in Pbylics will give a proud Man a Tincture of $\operatorname{Acbei} \mathrm{Fm}$, a deep Search into Nature will certainly bring him back to a Religious Senfe of God's Wifdom and Providence.

THo:

## to John Chamberlayne, $E f q$;

THo' we have lately had feveral very good Books upon this Subject, this will not be lefs acceptable, becaufe it contains feveral fine Ob fervations annd Experiments, which are altogether new, as is alfo his Manner of treating the moft common Pbanomena; from which he deduces admirable Confequences in favour of a Religious Life. And I think I may fay this for the Tranflation, thatit will perhaps do more Good than the Original ; becaufe in giving us all his Arguments for Natural Religion, you have omitted thofe which his too eager Zeal made him alfo draw from the Modernt Pbilosophy for Reveal'd Religion; the Weaknefs of which latter might give thofe FreeTbinkers occafion to triumph, who would be ftruck duinb at Convictions from the former. If I can be of any Service in helping you to look over the Sheets, you may readily command, Sir,

> Your mof Humble
> And Obedient Servant,

Chanucl-Row,
Wefrizinfer, Feb, 2. $171^{7}$.

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## T.HE

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# Author's EPistle 

## TOTHE <br> RE A D E R.

 HE Defign of Writing thefe Contemplati ns, is to convince Atheifss of the Wifdom, Power and Goodnefs of God, the Maker and Ruler of all Things; and Infdels (who indced acknowledge a God, but reject the Authority of the Holy Writings) that the Scriptures are of a more than Humane Original ; and fo to reprefent to both of "em theright Useof the Contemplationofthe Worid.

The Methods we have made ufe of to prove the fame, are only taken from the modern Obfervations, and probable Difcoveries in Nataral Pbilofophy, without laying down any bare Hypothefes; fince in the Things of natural Knowledge we have no farther Foundation for Arguments than we can produce Experiments: Upon which you may confult the Writings and Plans of the Rcyal Accdemies and Societies, and of the moft famous Ma thematicians among them.

The Reafon why I have not made ufe of the Metaphy ficks, \&rc. will appear in the Prefave, Sect,27.

While I was writing this, the Arch-Gifoo of Cambray's Book fell into my Hands; and white I was compofing the Prefice I met likewife with Mr. Ray's Book, tranflated into French; and was Voi.I.
moreover inform'd (tho' I don't underftand the Language) that Mr. Derloam had publifhed another Book in Englijp, wherein he largely proves the Being of a God upon the fame Foundation. It was very agreeable to me, to fee and obferve, that this Way of Proof, which I have always eftermed the ftrongeft, was likewife embraced by fuch Great Men; in which, after all that is writ upon it, there ftill remains abundance of Matter to convince the unfortunate Philofophers of the Perfections of their Great Creator ; and there will ftill remain enough to lateft Pofterity.

The Manner of proving the Divinity of the Holy Srripture from natural Pbanomena or Appearances, which we here fet before you, has not, that I know, been ever done before in fuch a Method. I hope, however, that the fame may be of Ufe both to the Atheift and Infidel, becaufe both thofe are wont chiefly to exercife themfelves in the Siudy and Knowledge of Nature.

The general Method of convincing both of 'em, is more largly reprefented in the following Preface, SeEF. xxix, xxx and xxxi.

I write in the Low-Dutch Tongue, to the End that I may be more ufeful to my own Countrymen; and efpecially, becaufe that Tongue has been often abufed in Publifhing and Difperfing Atbeifical Books.

The Order we follow can in fome Manner be tearned from the Heads or Contents of this Work; tho' I have not confined my felf very ftrictly to that which has been purfued by many others upon the fame Subject.

Thofe who will read this Work as an Experimental Account of the Knowledge of Nature, muft not be offended at what we call the Convictions, which they frequently meet with, becaufe our Defign was not to write a Body of Pbyficks on'y but
but to bring the Erroncous into the right Way; and by turning their Thoughts, after this manner, to the Knowledge of Nature, to lead them on to the true Notions of the Deity.
The able Mathematicians may perhaps think, that I ought to have propofed the Experimental Demonftrations, for Inftance, of the Power of the Mufcles, and of the Hydrofatical Laws in Fluids, \&c. in a more Mathematical Manner, or elfe barely related them without any farther Proofs, and fo to have made the fame Conclufions, without fo much Trouble, and fo many Figures : But they muft be pleafed to know, that I have deduced thofe Demonftrations as far as it was poffible for me, by Experiments only, and not as the Mathematicians are ufed to dofrom Effablijh'd Lawus of Nature, to the End that I might be the better underfood by fuch as know little or nothing of the Mathematicks. I was indeed at firft of a different Opinion, and had already prepared the whole Work without any Figures, and without Proofs, the Grounds of which were neverthelefs rery obvious to Matbematicians. But forafmuch as a certain Learned Gentleman, and after him feveral others objected, that if I did proceed in fuch a Method, many would think that what I fhould advance in fome Cafes, was more incredible than true ; and that in fuch grear Matters one ought to bring at leaft as much Proof as would be neceffary to confirm the Truth of one's Pofitions: I have therefore chofen to go on in that Way. This has likewife been the Reafon why this Work, which I was forced to enlarge and alter in every Part almoft, has feen the Light feveral Years later than it ought to have done, efpecially fince my other Affairs have continually obftructed the fame.

They who upon good Grounds do acknowledge a God, and the Divine Origin of the Holy Scri-

## iv The AUTHOR's Epifle

ptures, will here find fufficient Proofs of their Confeffion; and thofe who are weaker, may likewife, I hope, be confirmed in thofe Truths againft any Temptations.

But before I conclude this Addrefs to my Reader, I muft entreat thofe unhappy Philofophers, thofe wavering and doubtful Perfons, thofe Infidels, and much to be lamented ftrong Minds, for whom this Work is chiefly calculated, that they would come prepared to confider the fame, not fo much with an acute, as with a ferious Judgment, and decent Refpect for fo momentous an Enquiry; and not fo much to obferve what Difficulties may occur in fome Particulars, as whether there is not fomething in fuch a Number of Things as may ferve to convince them of the Perfections of their Maker, and of the Authority of his Word. If they proceed in the firft Way, the ftrongeft Proofs will be of no Ufe to them ; but if they fall into the latter, one fingle Fact weighed by a Mind in earneft, and difpofed to learn, may, by God's Bleffing, convince them of their Errors.

The Thetical Way, which is only made ufe of here for their Conviction, muft not appear imperfect to them, as if it did not fufficiently confute their Sentiments; but let them compare it with their own Pofitions, and juidge themfelves, whether a Proof deduced from certain and actual Experiments, which is the Cafe here, ought not to be more convincing, than that which is grounded upon naked Ideas; which, without any actual Experience to fupport them, are arbitrarily advanced for Notions of things really exifting; and that their Philofophy is only built upon this latter Foundation, they themfelves muf know. Accordingly, the Sophiftical Arguments of thofe Atheifts, and the not only falfe, but horrible Confequences flowing from their Opinions, have been already
fully expofed by divers eminent Perfons, to whofe Writings we refer you.

If there fhould be any thing among all thefe Contemplations, in which, according to the Opinion of the Reader, I may have been miftaken, and have not rightly reprefented the Properties of the Natural Pbonomena, let him pafs it over, fince he will not be able to fay the fame of all the reft ; and in cafe he allow one fingle Proof to be ftrong enough among fo many as are here brought together, or of thofe whereof the farther Contemplation of the World may yet fuggeft a much greater Number to him, that alone will be powerful enough to convince any Man that argues rationally, of the Being of a God, and of the great Origin of his Word; fince one Demonftration proves as ftrongly as feveral, though more do ftrengthen the Conviction.

Neither let the Quotations of Scripture-Texts, in thefe Difcourfes, make you reject the whole Work without reading it, as many are ufed to do when they meet with them in any Books, fince the Divinity thereof is not here fuppofed but proved; and that fome of them ferve to fhew the Wifdom and deep Knowledge in Nature of him that infpired them; and others, to convince you that no Man, tho' never fo underftanding, nor any Impoftor tho' ever fo cunning, either for Political Reafons, or otherwife, was capable to produce in thofe Times fuch things as we find written therein, from whence you may eafily conclude who has been the Author of them.

Let not the Atheifts and Unbelievers conceive a Prejudice againft this Work, fince they may learn not only from the Title, but from thofe fincere Affurances we hereby give them, that we did not write it out of the leaft Hate or Contempt of them, but from a hearty Sorrow for their Converfion; for which Reafon I have commonly made them themfelves the Judges of the moft part of my Conclufions: I therefore only intreat them that they would pafs their Judgment upon what is here fubmitted to it, without that deplorable Refolution taken up by many of thofe who call themfelves Strong-Minds, or Free-Thinkers, not to acknowledge the Being of a God.

One of thefe Pofitions muft be irrefragably true (it being impoffible to lay down a Third) either that, according to their Opinion, all Things in the World are govern'd by Chance, and by neceflary Laws, without the Intervention of an Intelligent Being, and that the Cbriftian Bible is compofed by Cheats and Impofors, who had no other View but their own Advantage ; or elfe, that the Holy Scriptures are given by a God that Governs the World, and who will require an Account from thofe Creatures whom he has endued with Reafon, how they have ufed the fame. Let them therefore confider how much it imports them not to be miftaken in thofe things whereon their eternal Welfare or Mifery depends; and let them judge whether it be not at leaft as true, that they and the World are made by a wife God, as that a Clock, or any other ingenious Piece of Workmain/hip, does prove the Skill of the Maker. Upon all which, if they ferioufly contemplate, they will tremble at their own Notions: And fince it is a Matter of Fact, and not a meer Speculation that is in queftion, and ought to be examined, whether it be not neceffary to enquire into the Things themfelves, without relying upon naked and atheiftical Notions; 'tis for this End thefe Contemplations are written. May the Almighty Go D, who alone can over-rule our Minds and Thoughts, enforce thefe and other Proofs, in which the whole World abounds!

## (.vii)



THE

## PREFACE,

 OR
# INTRODUCTION, 

 TO THEFollowing Contemplations of theW ORLD.

Section I. The true Difference between Atheifts, and thofe that fear GOD.
drywhen T is hardly credible, that there were
 ever any Men, who had not quite loft their Underftanding, fo foolifh and unreafonable as to deny an Eternal and Self-exiftent Being, and to maintain that there has been a perfect State of Inanity or Notbingne $s_{s}$, in which there were neither Creator or Creatures, for even the moft Famous among the Ancients, and Spinofa himfelf among the Moderns, tho' they may juftly be rank'd with the Atheifts, have yet acknowledged an Eteraal Eeing.

The great Difference therefore between Atheifts, and thofe who confefs and fear a God, is not whether rhere be fuch a Being, which from all Eternity has fubfifted by himfelf (for that is owned by them all, at leaft by all that I have ever heard of ) but whether this Eternal Being is alfo Wife, Power ful, and Mercifut; and whether He has made all things according to his own Pleafure, for certain Ends and Purpofes, and does continually direct and govern the fame.

It is true indeed, that thofe miferable Wretches find themfelves obliged, in fome Manner, to confefs his Power, were it only from their daily obferving, with their own Eyes, what great Bodies are moved in the Heavens with an unfpeakable Swiftnefs; and perhaps alfo, they might own his Goodness and Mercy, if we allow them to explain it in their own Senfe, and to afcribe the Goodnefs of this Being only to the happy Qualities of Things, making ufe therein of their own Underftanding, by which they think they are able to convert moft Things that occur to them in the World to their own Advantage, and to render them fubfervient to their own Neceffities and Pleafures: But with. great Difficulty will they allow, upon their Principles, that this Eternal Being is Wife, and orders all Things according to his own good Pleafure; becaufe fuch a Conceffion would be entirely inconfiftent and contradictory, as well to a meer Chance as to all the unknown Laws of Nature and Neceffity. This is alfo the only Foundation of their continual Uneafinefs and Terror ; fince if this Being is Wife, and knows that they endeavour blafphemounly to rob him of his Attributes and Perfections, they may eafily conclude what will be their Reward hereafter.

That

That this was likewife the old Queftion in former Ages, may be inferr'd from the Writings of Cicero about it ; where the Difputations of the Philofophers, by him introduc'd, do not fo much turn upon the Exiftence of a God (meaning thereby fuch an Eternal Being) as concerning the Nature of the Gods. It may therefore feem ftrange, perhaps, to thofe who from their Youth upwards have been fo happy as always to acknowledge and reverence GOD, for their Almighty Lord, Maker, and Preferver, out of a Conviction of his adorable Perfections, to hear that there can be found a Set of Men, who owning an Eternal Being, or the Exiftence of a God, do neverthelefs confider him as deprived or divefted of the above-mention'd Attributes: And yet that both the former and latter Times have fwarmed with fuch deplorable Genius's, is too well known to fill this Book with the Relations of them. We fhall therefore fatisfy our felves with acquainting the Reader, that the following Contemplations are exprefly calculated to bring thefe unfortunate Men, if it be poffible, to better Thoughts.

SEC T. II. In order to bring Atheifts to Reafon, it is neceflary to inquire into the Caufes and Remedies of Atheifm.

That we may therefore take the true Mcthods to arrive at this great End, it feems neceffary in the firft Place, ferioufly to enquire what are the real Caufes that many fall into fuch deplorable and irregular Opinions concerning this Tremendous and Eternal Being; and when we have come at the Knowledge thereof, to find proper Remedies to prevent the fame.

But the Reader is defired to take Notice, that we do not intend to treat of this Matter in its utmoft
utmolt Extent; we fhall Catisfy our felves only to collect fuch of the Caufes of modern Atheifm, which we have experimentally obferved to prevail over the Minds of thefe Impious Difputers, and from thence fuggeff fuch Means, as the fame Experience has taught us to apply with good Succefs againft this deplorable Evil.

Sect. III. The Firft Caufe is Inordinate SelfLove.

The firft Caufe therefore, and which mofly prevails in the Nattire of Men, is ufually the Paffion of too extenfive and inordinate Self-Love.

From hence only it is that Men defire to gratify their Inclinations, and to be in Subjection to no body ; and if they cannot be exempted altogether from the latter, they wou'd have it be no other kind of Subjection than what is agreeable to their Carnal Appetites. Wherefore, hearing that there is a God, and that he is Juft and Holy, and will be obey'd by them in all Things, and will certainly punifh thofe his Creatures that refufe to acknowledge his Power, they earnefly wifh to be entirely freed from it.

This induces them to turn a deaf Ear towards all the Convictions of fuch a Being ; and forafmuch as their Confciences, in fpight of all their Endeavours, will not fuffer them to be eafy, they are continually feeking out for Arguments, whereby they may perfwade themfelves of the contrary; and fo fiffe the dreadful Remorfes of fuch their refifting Confciences. For thefe Reafons did the blind Heathens afcribe to their Gods, Pafjons and Inclinations like thofe which they felt in themfelves; pretending that thofe Gods delighted in Drunkennefs, Fornication, Adultery, and other irregular Affections.

To look for no farther Proof of what has been advanced, let every Man who has been fo unhappy as to hunt for Arguments to darken and blot out of his Mind the Knowledge of the Perfections of his Creator, retire into himfelf, and examine, whether if that which is received by Chriftians for the Word of God, and in which his Will is contained, fhould allow him to abandon himfelf to all his Inclinations in this Life, and fhould promife him the Enjoyment of the like Pleafures through all Eternity, he would not endeavour with as much Zeal and Diligence to find out Reafons whereby to convince himfelf, and every Man befides, that there is a God, and that the Bible is his revealed Word, as he now Attempts to make himfelf and others believe that the fame is falfe. There is, however, an innate Defire in every Man to become happy: Does he expeet to find this in the Knowledge of a God? then will he extend his Defires that way: But perceiving, that by the Acknowledgment of a Supreme Holy Being, he would confequently be obliged to renounce his finful Pleafures, he will wifh that there was no fuch thing as fuch a God; tho' he dares not own the fame, leaft he fhould be found out by others for what he really is, a miferable Atheift.

I appeal for the Truth of what I have here faid to thofe Men who have ever lived in thefe fad Doubts and Uncertainties, and in the mean time followed their Paffions as far as they could, without incurring the Punifhment of the Temporal Magiftrate, and without Prejudice of their good Name or Eftate, but have at laft attained to a better Mind. It is not neceffary to produce Examples of thofe who after their Converfion have openly avow'd the fame, tho' I could eafily do it.

Sect.IV. The Means to prevent this inordinate Self-Love.

Now fince this whole Miftake is nothing elfe but a Paffion that hurries them away without the leaft Foundation or Shadow of Reafon, many of this kind of Atheiffs are reduced to the right Way, when God (who in all thefe Cafes muft be acknowledged to be the filft Caufe) fhall pleafe to fanctify the Means that are ufed thereto ; which, befides the Increafe of Years, that often calms the impetuous Paffions of Youth, do likewife fometimes confilt herein, to wit, that they be brought to a right and ferious Confideration of the W.fdom, Power and Goodnefs of God, which undeniably manifeft themfelves in the Contemplation of the World, and the Government of all Things in a multifarious Manner, to fuch as are noe refolved to remain wilfully Bind; efpecially, if the corrupt State of themfelves, and of all Mankind, and the Vatity of thofe Things upon which they beftow the Name of Pleafure, be fet before them in a proper Light; and efpecially that unhappy Condition in which all Men would find themfelves, if, according to their own Opinion, the World were govern'd either by meer Chance, or by the Laws of blind Fatality. Finally, how dreadful would it be for them in cafe their deplorable Notions (for I cannot beflow a better Term upon them, fince no body can prove them) fhould be entirely falfe. By which Confiderations, a lower Value for prefent, and a greater Concern for future Things, would be produced in their Minds; which being oppofed to their former Paffions, might contribute to extinguifh the fame, and awaken in them fuch ferious Thoughts, as fometimes are alone fufficient to make them change their Opinions. SECT.

## S ec t. V. The Second Caufe is inordinate Ambition.

The fecond Caufe of Atbeifm is another Paffion, confifting in an irregular Ambition, which arifes from the fame Source of Self-love, by which fome, having once abondoned themfelves to the Defence of $\int$ uch unfortunate Sentiments, fancy that they ought therefore to pafs with other Men for Perfons wijer, and of greater Underffandings; and fo they beltow upon each other the Appeliation of EJprits Forts, that is to fay Strong-Minds, or Free-Thinkers; being, as it were, defirous to fhew thereby, that they are fuch ftout and couragious Men, as are not to be terrified with vain Fears and Bugbears (as they term it) like the Vulgar and Childifh People.

This is one of the higheft Steps to which Atheifm can attain, and indeed it cannot well climb higher; becaufe, when it is once arrived to that pafs, it does not only flight all Convictions, but fo long as this Paffion and inordinate Ambition continues, compels Men neceffarily to reject them, and confequently to remain altogether incurable. For whereas the firft fort of Atheifm, which is only founded upon the Enjoyment of Pleafures, may be filently oppofed and conquer'd as foon as any contrary Arguments begin to make an Impreffion, this laft has moreover this Obfacle and Hindrance in the removing it, that thofe who have once maintain'd it, altho' they fhould change their Mind, are afraid of lofing their imaginary Efteem, and the Honour of a Superior Wifdom and Knowledge, and of being henceforwards accounted by thofe that know them, not only Cowardly and Unconfant, but likewife Men of miftaken Judgments: It being commonly the way of thefe conceited Strong- daily Experience in many Cafes; infomuch, that this unhappy Sort of Creatures have been ofren obferved to break forth into dreadful Blafphemies, only to give a Proof of their greater Knowledge and Penetration, and to avoid the fufpicion of fpeaking againft their Confciences, and of diffembling their juft Fears.

## Sect. VI. The Remedy againft this Evil.

I have feldom feen any Humane Means made ufe of with Effect againft thofe who will not be convinced; fince this kind of Atheifm is attended, for the moft part, with great Ignorance; and that thofe miferable Wretches who are tainted with ir, can be feldom brought to liften carefully to the Arguments objected againft them; being acuftomed to anfwer the beft and ftrongeft Proofs with Contempt and a fcornful Smile, not judging them worthy of a better Re turn from their fuperior Underftandings. Yea, whatever may be the Occafion of fuch an exceffive Hardnefs and Stiffnefs of Heart, it is vifible that they lie under a dreadful Judgment of that God whom they have fo unrighteounly blafphemed; and fo far as one may guefs from Circumftances, do often continue fo to the End, unlefs the fame merciful God be pleafed to take Pity on them, and make them unconceivable Miracles of his Grace.

Among fuch I knew one, who having been advifed by a Friend (for he was deaf to all other kind of Proofs) Cerioufly to confider him-
felf, his Soul, and Body, and all that happen'd in the World round about him, began to perceive that it was hardly to be believed, that he himfelf, and all befides him, could be made and govern'd by any thing but a Being endowed with great Wifdom: So that a little while before he died, he heartily thanked his Friend for the Counfel he had given him, and detelting his former wicked Thoughts with a Flood of Tears, he continued to his Death to beg Forgivenefs of that GOD, whom all his Life-time he had refufed to acknowledge; praifing, with his laft Breath, the unexpreffible great Mercy of his Divine Majefty, who had vouchfafed to look upon fuch an abominable Creature (that had deferved nothing but his Wrath and Vengeance) with the Eyes of Mercy. I have known others of this kind, fome of whom have in a harden'd Manner drowned themfelves; others, that have taken Poifon, and the reft ended their Lives in the utmoft Defpair upon their Sick-Beds.

## Sect. VII. Concerning the Death of Spinofa.

Upon this Occafion of mentioning the miferable Deaths of feveral Atheifts, I cannot forbear to take Notice of what has been related, and with great Truth, as far as I could difcover, touching that of Spinofa, that he ended his Life in Solitude and great Tranquility, without manifefting any external Signs of Uneafinefs. This I know feem'd ftrange to fome Weak but Pious Men, who had either feen or heard of very different and moft dreadful Judgments of GOD againft fome that had thus denied him ; and the Followers of this fame Spinofa, took an occafion from thence to think, that the Opinions of their Mafter were not fo unjuftifiable.
able. But for the Satisfaction of the former, they ought to be told, that God working with Freedom, does not always punifh Sins fo v.fibly in this Life; and as for the latter, if they have been converfant in the Writings of that Atheift, they may obferve from thence, that Spinofa is not fo much to be looked upon for a learned Difputant as for fuch a fort " of an Atheift, who with or without Conviction, was refolved fimply to adhere to his wicked Opinions ; becaufe, as he thought, they would make him pals his Life more agrecably.

I would not have it thought that I fay this of him out of Prejudice, but refer to his own Words, in his 34th Letter to the Heer van Blyenbergh; where he fays, firt, that he does not underftand the Holy Scriptures, and entirely acquiefces in the Suggeftions of his own Underftanding ; and then (inftead of proving the Certainty thereof, which would have become a true Philofopher to have done upon fuch an occafion) he proceeds thus, in a very unworthy Manner, to fpeak to fome Body that is feeking after Truth: And altho what I bave already advanced concerning the naturalUnderftanding, Gouild appear to be falle; yet I am happy, whilf I enjoy my Opinion, and pafs my Life eafily, merrily, and pleafantly, without Tears and Sighs, \&c. Now let wife Men judge, whether thefe Words fhew a Philofopher feeking after Truth, or an obftinate Atheift that will not be convinced, leaft it fhould fpoil his Mirth. It cannot therefore be denied, that God may fuffer a ftubborn Blafphemer to fall away fo far, that by perfifting a long time in his Errors, he becomes at laft entirely blind. and fo remains, till the impending Wrath of God fhall open his Eyes.

It is, moreover, very certain, that to the end he might not be difturbed (I mean Spinofa) he would
would not admit of any Difcourfe, whilft he lay upon his Sick and Death-bed, with any Body about the State of Men after this Life, and the Certainty or Uncertainty of his own Opinions; which alto does not look like the real Convictions of a true Philofopher: For tho' his Judgment might be fo weaken'd by the Violence of his Sicknefs, that he could not well weigh nor anfer the Reafons and Objections that were brought againft him to his own Satisfaction, it was neverthelefs true, upon his Principles, that he would not therefore be the more unhappy after bis, Death; but only that he could not have flatter'd and delighted himfelf with the Honour of palling for a a greater Freethinker than other Men.

Laftly, I may here add, that one of his mont particular Friends and Difciples (well known to inc in my Youth) who always adhered to his Opinions, and maintain'd them, when he durf, with great Acuteness, being a Man of very good Parts, lying upon his Sick-bed, and remain= ing there in a long Silence and Indolence, in Amitation of his Matter, did at laft burt t out in thee dreadful Expreffions; That 'he now believed all that he had formerly denied; but that it was too late for bim to hope for Mercy. This was related to me, concerning the dreadful End of this Man, with all its Circumftances, by a certain learned Gentleman, who knew that I having been ac= quainted a great many Years with the Opinions of that unfortunate Creature, and hearing of his Death; should be defirous to be informed of the Circumstances thereof.

Now whether the Followers of Spinofa, after having well confider'd all that has been raid concorning the haft End of their Matter, have any Grounds for their Indolence and Indifferency, I Vol. I. leave
leave it to themfelves to confider; provided they will do it without Paffion and Partiality.

## SECT. VIII. The third Caufe is Ignorance.

A Third Caufe of thefe deplorable Opinions feems to be, in fome Men, a downright Ignorance. Accordingly I have met with fome, who having never exercifed their Underftandings in examining Matters, have blindly followed their Inclinations in all things, fo far as their Opportunities, which were few enough, would give them leave; and who being asked, what they thought of the World, and of its Beginning? openly denied that a God had made it.
3 I knew one of this fort, who, after having abandon'd himfelf to Drunkennefs for many Years, and paffed his ignorant and brutith Life in thefe deftructive Notions, died in the fame; at leaft it appeared fo to them that attended him during his laft Illnefs, and that related it to me.

I met alfo with another, that might jufty be ranked among the Number of thefe ignorant Perfons, who, tho' he was outwardly a regular and fober Perfon, yet when he was in the Company of thofe that were not very averfe to his Opinions, did not fcruple to fpeak out plainly, and to affirm, that every thing waas from Ndture (this was his Expreffion) So as it is: And when he was preffed more clofely to explain himfelf, alledged no other Reafon, than that it appeared fo to him, and that he could not conceive it otherwife; affecting, at the fame time, under this Darknefs and Ignorance, a certain Haughtinefs, as if his Underfanding was much fuperior to that of others.

Now, for the Converfion of this Sort of Atheifts, fince the beft Metaphyjgical Arguments make no Impreffion on them, forafmuch as they do not conceive them, nor will give themfelves the Trouble to fudy them, nothing feems to me more ufeful than to fet before them fuch Proofs as are only founded in thofe common Experiments, obvious to every Man's Sight; and I know that one of this laft Sort, who could not eafily be induced to difcover any Weaknefs or Doubts in his Opinions, was thereby obliged to acknowledge, that fuch Proofs made him a little uneafie.

SECT. X. The fourth Caufe is too great a Conceis of one's own Wi Wdom.

The Fourth Caule of Atheifm, as far as my Obfervations and Experience reach, proceeds from a too great Conceit of our own Widdom, and from an implicit admitting tbat to be Truth which wo are wont to deduce from our own Ideas or Notions. And fome Men are apt to advance fuch their Notions with great Arrogancy, as well concerning the Divine Attribures and Properties, as about the fmallelt Appearances in the Creatures: In fhort, they except nothing, and pretend to reduce every thing to an infallible Rale of Poffibility and Impoffibility, Truth and Falfhood, Good and Evil.

This is the moft dangerous Kind of all: Fir $f_{\text {s }}$ Becaufe they deny every thing that they do not conceive ; and therefore all Divine Revelation (which is above their Underftanding) is not only rejected by them, but ridiculed alfo. Secondly, Becaufe they have the greateft Opportunity to fupport

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their Errors with fpecious and plaufible Arguments, and to evade the Force of thofe ObjeEtions that are brought againft them, which they immediately make ufe of as foon as their Adverfary commits the leaft Overfight or Blunder. Thirdly, Becaufe many of them, in their Converration, do affume an External Appearance of Morality, and other Social Virtues, whereby they fometimes acquire a certain Efteem with the Ignorant, which may be of dangerous Confequence; the rather, becaufe divers of them having learned the Elements of Euclid, Algebra, and other fpeculative Parts of the Mathematicks, pafs amongit the Unknowing for great Mathematicians; which Title does really $n 0$ more belong to them, than that of a great Philofopher to one that underfands nothing but a little Logick; fince People may be very well experienced in thefe Ideal or Notional Scierices, and yet be Mafters of very little, or no Knowledge at all, in Things that actually exift and come to pals.

But we muft not from hence conclude, that Guch noble Studies do of themfelves lead thore miferable Men into fuch erroneous Opinions; for thefe in many Cafes, open the Way to the Difcovery of the Wifdom of God in the Works of the Creation, to which we could not otherwife attain: On the contrary, they are exceeding ufeful, unlefs when mifapply'd by thefe half-learned Men, who being puffed up with a little Knowledge, fancy they know every Thing, and defpife all thofe who do not juft underftand as much as they themfelves, about Lines and Quantities, tho' they be much wifer, and more judicious in other Kinds of Learning.

## SEC T.XI. Spinofa briefly confuted.

THUS we find at prefent, that in order to make even Atbeiffical Writings to pafs for uncontroverted Truths, the Authors thereof have endeavourd to give them the Form of Mathematical Demonftrations. A remarkable Inftance of which may be feen in the Book of Spinofa, which has for that Reafon gained fo much Credit with many of thefe unhappy Perfons ; becaufe thofe who do not rightly underftand the Mathematicks, judge from the External Appearances, that what is laid down therein is deduced from juft Matbematical Principles.

Perhaps we may hereafter find an Opportunity more fully to fhew the Miftakes that are there advanced under the Name of Demonfrations, when we fhall compare 'em with fuch as are truiy $M_{a}$ thematical.

To fay a Word or two thereof en pafant :
1.There are two Kinds of Objects, about which the Matbematicians do treat or empioy themfelves, viz. Ideas fimply confidered as fuch, and Ideas of Things really, exifting ; that is, to fpeak more clearly, Mutbematicians difcourfe either only about their Ideas, or elfe about Things that are really exifting out of their Ideas.
2. The firf Manner is feen in the Speculative Geometry, fuch as the Elements of Euclid, Algebra, Oc. where they conccive a Point as fomething that has no Parts, a Line without Breadth, ơc. So likewife they here confider Magnitudes, which have more than three Dimenfions, $\sigma_{c}$, which every Body knows are only certain Ways of our Conceptions, baving no real Exiftence out of them.
3. The fecond Kind of Object occurs in Aftronomy, Opticks, ofc. where things are confidered, which, befides our Ideas of them, have a real Exiftence in themfelves.
4. The Foundation of the Firft, befides Axioms, are Definitions, in which they defcribe their Ideas, without troubling themfelves whether there is any thing really exiting that agrees therewith: Intances of which we have juft now given. Accordingly it is with them a Truth, that the three Angles of a Triangle are equal to two Right oner, and wou'd Itill be fo altho every thing in the World were circular, and that there were not really fuch a Thing as a Triangle.
5. The other way is founded upon Experiments and Difcoveries, which either they themfelves, or other credible Perfons make of Things which are out of their Ideas, and fomething more than meer Conceptions. Thus a good Afronomer lays down for the Foundation of his Science, that which he, or thofe whom he can believe, have experimentally difoover'd, namely, that there is peally fuch a Thing as a Globe of the Earth, a Sun, a vifible Moon, five Planets, fome of which have their Satellites, or Bodies circulating about them, and a great Number of fix'd Stars ; but does by no means extend his Imagination or Fancy to the Suppofition of other Worlds, and other forts of Bodies; as for Infance, that there are ten Suns, a hundred Moons, a thoufand Planets, and a very few fixed Stars; of which imaginary Worlds he might neverthelefs bring a great many Proofs, which according to the firlt Way of arguing, we may allow to be Mathematical enough, but when adapted to the Things themfelves, would appeat to be entirely falfe.
6. Now thofe that have read and underfood Spinofa, are fenfible that he only lays down his
own Ideas and Notions for the Foundation of every thing, which therefore needs not to be farther proved here: From whence it may appear to every one, that he applies this manner of difcovering Truths prepofteroully to Things really exifting, of which true Mathematicians never make ufe, but only about their own Ideas: wherefore the whole Series of fo many Hypothefes and pretended Demonftrations in Spinof $\mathrm{f}^{3}$ 's Book (tho' he fhould argue rightly upon thofe Principles of which, however, the contrary may be proved in many Cafes) do reprefent nothing elfe to us than only the Properties of thofe Imaginations or Conceptions which that unhappy Author had formed in himfelf; nor can any Man thereby conclade any thing more from the Things themfelves than an Aftronomer can do, who advances his own Fancies for the true Structure of the Heavens.
7. So that from this Miftake alone the Weaknefs of all Spinofa's Arguments appear at one View, and how little his Way of Demonftrating agrees with that of true Mathematicians.

SECT. XII. The Remedies againft this Fourth Caufe.
But to return from this Digreffion. Since thede unhappy Philofophets aferibe fo much to their own Underftanding, and do exero their whole Strength to oppofe the Weight of alb Metaphyfical Arguments, tho' they are fupported by ftrong Reafons; the only Way that I have ever fecri ufed with Suceefs to overthrow their prouid Fancies, that they can conceive every thing and to fliew them the Narrownefs of their Underftandings (which is particularly neceflary to their Converfion) is this: Let them be brought into a Chymioal Laboratory, or other Places where People are wont to make Phyfical Experiments, 'fuch as' are not

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commonly known to every Body, and let them be asked what will be the Refult of fuch, or fuch an Operation, purfuant to their own Notions and Conceptions? In which, if they miftake, and Things appear quite contrary to what they expected, they can have no Subterfuge or Evafion, but will be compell'd to acknowledge, that their Underfandings have been very little converfant upon Objects really exifting: And in cafe they themfelves are verfed in natural Experiments, let them be defired to contemplate, without Prejudice, the Manner how every thing they fee cames to pafs, and to think whether the Power and Wifdom of the Great Creator and Ruler of all Things does not appear as inconteftably in them, as the Judgment and Skill of any Artificer in the Machines that he has invented.

Sect. XIII. The firf Steps to Atheifm are Prejudices.
Besides the above-mention'd four Caufes, there do occur to me other Steps or Inducements to Atheifm; which tho' they cannot properly be eifteen'd Caules, ass the former, yet they, are ufed by many as Steps towards it; and tho' they do not always bring Men to deny, yet they do at leaft tempt them to doubt of the highef Truths.

The firf Sort of there are our Prejudices, fome: of which we bring into the World along with us, as others proceed from the Slavifhnefs of our External Senfes. Thus Men fancy, for Inftance, that the Sun is no bigger than a Trencher, of little Difh, and that its Diftance from us is very. frall : In the fame Manner the Planets appear to. us as little contemptible. Things. This being deeply impreffed in our Minds, tempts us to look upon the Greatnefs of God with very fmall Refpet or Reverence ; fince from fuch Appearances
we judge there was very little Power neceffary ta form and govern them ; Whereas, if we did (as we ought to do) confider the World in its immenfurable Expanfion, the Sun as'a Globe of Fire, of a moft amazing Bignefs, and the Planets as fo many thoufand rimes bigger than this whole Earth, they woind excite in us quite other Sorts of Conceptions, and make us ftand abafhed at the great Power of our adorable Creator and Ruler.

Another Prejudice, which hinders us from obferving the Wifdom of God in the Direction of the vifible World, is, that when we cannot fee either Bodies or Motions, we are prefently apt to fancy that there is nothing either of Body or Motion but what we can fee with our own Eyes; for believing that that which is in Reft will always remain f , and that nothing elfe is requifite to continue it, it feems to us as if neither Power nor Direction were neceffary thereto; and that Fancy infenfibly leads us either to deny altogether, or at leaft hardly to acknowledge any Divine Providence in thofe Things and Places. Thus do many imagine, that in a Chamber, for Inftance, which is full of Light and Air, all Things are ftill and quiet, and confequently that there is no Want in that Place of any Power and Wifdom to preferve us from Accidents : But if one were to reprefent to fuch Men the incredible Strength of the Air furrounding them, and that without the Intervention of a Wife and Powerful Being, which continually reftrains its refiftefs Violence by a Counterroife and Ballance of Force, they would be crunhed to Pieces in an inftant: And fo if they were made to conceive the terribic Motions of Light, which unlefs it were govern'd by certain Laws, by which its Rays are feparated and icatter'd, would, in the Space of a few Minutes, put this whole Gipbe

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of the Eaith in a devouring Conflagration; who could doubt, if he had the leaft Spark of Reafon in him, that he has not from hence the jufteft Caufe imaginable to praife and extol the Greatnefs, Power and Wifdom of a God, who only preferves us from all thofe Dangers, and hillders us from perifhing in fo miferable a Manner !

Sect. XIV. The Means to cure Men of the fe Prejudices.

No w in order to be cured of the fe Prejudices, we are taught by what has been already faid, that it is heceffary to enquire experimentally into the true State and Nature of Things, and afterwards to form a right Notion of them from thofe Proofs which are drawn from undeniable Experiments, and frequently to meditate upon the fame; this will make us, as it were, feel with our Hands the Power of the great Ruler of all Things, if we do but carefully attend thereto.

> SECT.XV. The fecond Step, the abfurd or wirong Manner of defrribing Nature.

The fecond Inducement or Inlet to Atheifm (tho' upon many Occafions it is in itfelf ufeful and neceffary, but by an imprudent Application ferves to corrupt Mens Underftandings) is an $a b$ furd and falfe Manner of Philofophifing, or rather of Inftructing any one in the Knowledge of Nature; under which Head I refer, in the firft Place, to fuch fort of Books as perhaps are not written with an evil Defign, but which, however, if yous will believe the Authors themfelves, pretend to give a true Notion of the whole Frame and Confruction of the World, and of all its vifible and invifible Parts without Exception; defribing

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after their Manner, with as much Affurance as if they had been prefent, and were God $A_{\text {I- }}$ mighty's Cabinet Council, how he made the World, how he put all Things together, and how he has produced and continued the Motion thereof; and (which I have often been furprized to hear from the Mouths of fuch as were otherwife Men of good Senfe) even how every thing between the Circumference of the ftarry Heavens, and the Centre thereof, were made in the Beginning of the World.

No w, if fo be that any Man fhould fall into fuch an unhappy Opinion, as to receive for Truth all that he finds written in fuch Books, how can he do orherwife than believe, that there was no more Wifdom requifite to bring this glotious Frame of the World into fuch a beautiful Order as we fee it, and to continue it in the fame, thah what the Authors of fuch Books were Mafters of? And how far this may in time minead a great many young and unexperienced Perfons, and divert them from that Wonder and Reverence which is due to the endlefs Wifdom of God, it is eafie to imagine, and fome have found by fatal Experience.

SECT. XVI. The Inconveniencies of Deducing every Thing from an Hypothefis.

To this wrong Way of Thinking may be afcribed the Manner of Deducing all the Phoenomena of Not. ture from a certain Hypothefis. Now it will be very eafie to fhew, how many Occafions of falling into irreverent Thoughts of God's All-ruling Providence this imaginary manner of Philofophifing furnifhes Men with; fince fome Underftandings obferving that it cofts them more Pains to comprehend any notable Mathematical Propefition, or to
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folve an Algebiaical Quteftion, than to reprefent to themfelves the Caufes and Operations of all that belongs tothe vifible World, upon the Foot of fuch an Hypothefis; the great Work of the whole Creation appears to them more eafily to be conceived than fome of the Inventions of the Mathematicians. From whence therefore a tacit Confequence is deduced by little and little, that towards the Conftruction and Government of the Heavens and the Earth, lefs Wifdom is required than what many Perfons, whom they look upon to be great Mathematicians, are really poffeffed of; and this does proportionably diminifh the Reverence which they ought to have for the Wifdom of their Great Creator ; the Lofs of which is oftentimes one Stone of Offence, upon which fome of my Acquaintance bave firf fumbled, and afterwards fallen.

Thofe who have been intangled in fuch a Labyrinth, are wont zealoully to engage themfelres yet farther therein, and, againft all the Convictions of contrary Experiments, to fupport their Hypothefes with all their Might ; perfwading themfeives with a fecret Pleafure, that without beftowing any Trouble or Charges upon Trials, their own Hypothefes will ferve them for a true Key to open the moft hidden Secrets of Nature: And to the end that they may not be brought into any Doubtings concerning the fame, from this Ob fervation, that there may be more than one Hypothefis, from which the fame Effects are deducible (as is known in Aftronomy and other Cafes) many of ' cm are accuftomed to lay down this Maxim, That an Hypothefis may be fafely maintained to be the moft true, becnufe is is the moot fimple: Which Argument is of much the fame Force, as if any one fecing a Watch going in a Chamber, pretends to have rightly proved, that the fame is moved by a Weight,

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Weight, and not by a Spring, becaule the former of thefe appears to be the moft plain and fimple.

Finally, this Hypothetical Philofophy is ro much the more prejudicial, that it neceflarily obliges Men to fancy that they have attained to a fundamental Knowledge of even the moft principal Things that occur in Nature; fince every one mult expect to be look'd upon as a compleat Fool, in cafe he prefumed to find out an Hypothefis which was proper to account for Phoenomena wholly unknown to him ; forafmuch as any Alteration in the Fbenomena muft likewife neceflarily produce Alterations in the Hypothefis; and this cannot be done without occafoning too mean an Opinion of the Works of our Great Creator, and even of the Creator himfelf.

To difentangle themfelves out of fuch a Labyrinth, more Pains are requifite than a Man who has never tried it can perhaps imagine; efpecially, if fuch Perfons be pretty far embarked in thefe Studics. Every one who has had the Trial of it, knows how mortifying it is to give up an Hypotheris which he has believed and maintained for many Years to be true, upon which he has pored and meditated fo many Nights, with which he has blotted fo much Paper, and for the fake of it, ran thro' fo many Books; and, laftly, by the help of which, he fancies to himfelf, that he is arrived to the Top of all Wifdom, or at leaft, that he fhall foon reach it. He that has a mind to fee an Inftance thereof, let him perufe the Preface to the Anatomy of the Brain, by the Learned Dr. Willis.

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## Sect. XVII. The Remedies againft this Evil.

No w, in order to prevent the being feduced by this manner of Philofophifing by Hypothefes only, it is firft neceffary, that Men fhould not dwell too long upon thofe fpeculative Studies, tho' they fhould filently flatter us with the Fruitfulnefs of fuch Hypothefes, and the Reprefentation of the Greatnefs of our Underfanding; but we fhould give ourfelves up to actual Experiments, not enquiring into the Opinions of Men, but into the Nature of Things themfelves; and fatisfy ourfelves of the Power and Wifdom of the adorable Creator, after a quite different and more pofitive Manner, and learn how great is the dif-ference-between knowing any thing Experimentally; and gueffing at it Hypothetically.

## Sect. XVIII. Another Remedy.

Another Way whereby we may fecure our felves againft the Evil Confequences of thefe kind of Studies, is, when we are asked about Things of which our Ideas are not fufficiently clear, to anfiver calmly, and without blufhing, I know not; and by no means pretending by this, or that uncertain, or undemonftrated Hypothefis, to give an Account thereof, for fear of lofing the Refpect that belongs to us. This will prevent the naturally high Conceptions which we have of our own Underftanding, from throwing Dult in our Eyes; and it is the true Means to make us think humbly of ourfelves, and to contemplate with Wonder the Works of our great Creator.

I know very well how hard a Thing it is for one who has an Opinion of the Fame of his own Leaming, and who has devoted himfelf to thefe Studies,

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Studies, to be brought to a frank Confeffion, that there is Something which be does not know; the rather, becaufe this or that Hypothefis may feem always to furnifh him with a Back-door to evade fuch an Anfwer. But tho' this be a littie fhocking at firft, yet the Man who is truly knowing, will foon bring himfelf to confefs, that there is fuch a Thing as an Eruditum Nefcire, or a Learned Ignorance, viz. in fuch a one, who knowing at firf what Great Men have pronounced about a certain Thing, yet can fhew experimentally, that their Opinions are not to be received for Truth; and being himfelf asked about it, confefles his Ignotance without Reluctancy. This will by no means leffen the Efteem which he has acquired by his Learning in the Opinion of wife Men; and yet will produce this Fruit, that quite different from many unhappy Atheifts, who fall into Error, thro' a Conceit of knowing all Things, he will acknowledge, that the Wifdom of GOD, as it fhines out in the Phoenomena of the World, does far furpars his own weak Underftanding.

## Sect. XIX. The Ufe of Hypotbefes.

We would not, however, that Men flould believe from hence, that we reject all Hypothefes as quite unneceffary; fince, if they be properly ufed, they are of great Service in many Cafes: not only becaufe they reduce the Thoughts of an Enquirer into a more regular Compafs, and hinder them from rambling out too far'; but chiefly, becaufe they are of a particular Advantage in directing the Judgments of young People, and fetting them a Pattern how they may afterwards Difcourfe and Argue from Experiments; provided it be done with fuch Prudence and Caution as may lead them to make a juft Diftinction between
the one and the other: Wherefore, it is commendable enough in thore Perfons whore Defign and Duty requires them to direet Youth in the Courfe of their Studies.
Before I proceed to any thing elfe, I can't forbear adding in this Place, that in reading the Works of thofe Philofophers' who pretend not only to defrribe the great Univerfe, even to the fmalleft Parts of it, with fo much Affurdnce, but do likewile undertake to account for, and make known to the World the Original and Principle of all Things, I have often thought, that if thofe Gentlemen had not had more and beiter Opportunities of difcovering how a Human Creature is born or produced than how the Univerfe or this Globe of the Earth are made; what ftange and abfurd Hypothefes would they have adranced upon this Subjeet; and without fucceeding or gueffing right in any one of their numerous Schemes, notwivithfanding that every one might perhaps be fupported by as many and as good Reafons as any of thofe concerning the Univerfe, which have no Foundation but in the Fancy of thefe Philorophers : Not to mention, that if the real Manner of the Formation of a Human Creature, as far as it can be known, were laid open to thefe Philorophers, without doubt fome of 'em would tell us, that they could have difcover'd a more fimple, and confequently a more probable Hypothefis thereof: And others would imagine that they could eafily prove that the true Manner of fuch a Formation ought by no means to be admitted; namely, that the Fatus can live, like a Fiih in Water, nine Months in its Mother's Womb; for they can demonftrate by unconteftable Experience, that nobody can live fo many Minutes under Water. They who pleafe to refleat upon there

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thefe Matters with us, may judge from thence how little Dependance there is on meer, tho' ingenious and plaufible, Hypothefes.

Sect. XX. A Third Inducement to Atheifm, to admit of no Final Caufes.

I Do not know whether I fhould not lay down this for another Step or Inducement to Atherfm, viz. the Maxim that fome have taken up and maintained, That in Pbilofophifing, no Notice is to be taken of previous Defigns or final Caufes.

I do not here blame thofe Philofophers who affirm, that in the Study of Nature, where Men enquire how every thing Is, ACts, and Moves, the Contemplation of Final Caufes have properly no Place; and I readily agree, that when one is ask'd, How does fuch a Thing bappen? it is ab. furd to anfwer, That it bappens for fuch an End or Purpofe. But this is neverthelefs true, that if fuch a Rule be admitted without any ReAtrictions, it may ferve to miflead Men into a raw Conception, that all Things are made without a View or Defign, and that meer Cbance, or unknoron Caufes, take place in the World: Yea, the Queftion, Why any thing happens? or, To zuhat End it is ferviceable? ought not to be entirely banifhed out of Philofophy, as unworthy of great Underftandings; tho we fhould allow, at the fame time, that it does not properly belong to that Part of Phyficks which contemplates the operating Caufes. This, I believe, every body will grant, who having enquired into Natural Things, has, with Pleafure, feen the Ufes thereof, and the Service which they render both to the World, and to Men.
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It is true, indeed, that in the Modern Philofophy, this is not taught abftractly from other Things; but as in Pneumatics, the Properties of Spirits; in Pbyfics, thofe of Bodies; in Mechanics, the Laws of Motion ; in Aftionomy, the Properties of the Heavenly Bodies; in Optics, thofe of Light and Vifion are handied; fo it occurs to me, and I think not without Reafon, (if one fhould treat exprefly about the Defigus and wife Ends of the Creator, and fhew the fame from the State of Things, and from their Ufes) that a Scopology, or Study of Ends, would prove one of the moft exalted Parts of Philofophy, and might contribute, not only to convince many (who otherwife forget God) of their Obligations, and juft Gratitude to their Great Maker ; but likewife to render Famous to all Pofterity, fuch as have been diligent and fucceffful in dif covering new Ules of Things, tho' the Things themfelves have been known long before. Thus we fee, that Harvey, in the Difcovery of the Circulation of the Blood, found out a Ufe that was nerer before known, of the Heart, Veins, and Arteries; fo did Malpighi, of feveral of the Parts of Animals and Plaits; fo did Borelli, of the $1 n$ ftruments of Motions; whereby they have all of them render'd their Names honourable to future Generations.

## Sect. XXI. The Remedies againft this wrong Notion.

How much the Experimental Examination of the Creatures is ufeful to avoid the Evil Confequences of fuch rafh Principles, the nice and exact Enquirers in this Age have fhewn us; efpecially the Anatomifts, who are wont, to all the Defcriptions they have given us of Ecdies, ex-
prefly to fubjoin the Ends and Defigns for which they are fo compofed, together with their Ufes; and very often expatiate from thence, upon the Praifes of the $W_{i} \int d o m$ and Goodnefs of that Being which has formed them; of which the abovemention'd laudable Gentlemen, Harvey, Malpighbi, Borelli, and a great Number more, are illuftrious Examples.

## Sect . XXII. The Fourth Inducement is Difputes.

The Fourth Inducement, which indeed does not of itfelf always beget Atheifm, but yet infenfibly leads to it, and even hinders Men from being convinced of the moft Fundamental and Divine Truths, is thofe numerous Difputes that are ftarted concerning them, and of which there is never any end.

This need not be proved to thole that are acquainted with the Divifions among the Ancient and Modern Philofophers, who tho they join perhaps on all hands, to defend the Being and Attributes of a God againft Atheifts, yet do not agree in (but frequently reject) the Arguments, brought by one another to prove the fame. By fuch continual Differences, (efpecially if Paffion and ill Language be mix'd therewith) Men that are not fettled in their Principles, are rendered yet more unftable and doubting; and there is too great a Haadle given to fuch as deny a God, to maintain, with fome kind of Probability, that all that has been faid and believed concerning Him, is not attended with fo much Certainty as it ought.

## SECT. XXIII. Means to prevent the Same.

Now to the end that we frould not be fubject to thofe Difputes, and that a total Stop may be put to them, we fhall here propofe a Means, which we hope may feem proper for that purpofe; which is ferioully to fet about enquiring, wherein the juft Characteriftick, or Mark of the Truth or Falfity of a Propofition or Enunciatioin, confifts : For if People did but agree in this one Thing, they might, without any farther Caviling or Difputing, judge with Certainty of a Propofition, in cafe it was accompanied with the right Marks of Truth, that it was True; and if it had the contrary Marks, they might pronounce it Falfe; and again, if thofe Marks were obfcure on both Sides, they would declare it doubtful and uncertain.

But fince it is more to be wifh'd than expected, that the Difagreement among Philofophers, about the Characterifticks of Truth, will ever be entirely laid afide; the beft way that I can think of to avoid, and put an end to Difputes, is to make ufe of fuch Proofs of the Truth or Falfity of a Propofition, that have their Foundation, not fo much in Arguments, as in undeniable Experiments, as often as it can be done.

Men mult be well confirmed in what has been here laid down, fince we have a clear Proof thereof in our Modern Phyficks; it being known to every one, at leaft allowed by the moft Learned, that in order to be affured of the Truth of a Pofition in this Science, the fame muft be demonftrated by Experiments; and it has been found, that the greateft Men of this laft Age have allowed Experiments to be the only CharaEterificlis of Truth, and that an end has been

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put by them to many Difputes, and that very few new ones have arifen in Natural Philofophy, which have not thereby been quafhed almoft as foon as they appeared. Thus all the Debates, Whether the Blood circulates or not? Whether Water rifes in a Pump by the Preffure of the Air, or not? Whether Nature can fuffer a Vacuum, or empty Space, or not? and a great many others, about which Men have fo long wrangled, are now entirely removed by unanfwerabie Experiments; and the Truth of the former, and confequently the Falfity of the latter, are proved even by O cular Demonftration: Alid fince the Motion, or Ref, of the Sun, has not yet been determined by any Experimental Proofs the moft famous Aftronomers have yet made, that mult be rank'd among thofe Things that are to be accounted uncertain : But of this we flall treat more largely when we come to the Contemplation of Unknown or Undicover'd T'hings.

Sect. XXIV. The Abufe of Academical Difputes.
Before I quit the S.bject of Difputes, I find myfelf obliged to reprefent, with great Submiffion, to thofe Gentlemen in whofe Power it is to reform thofe Abufes, (in cafe this Book Chould ever have the Honour to be perufed by them ) fomething that may prevent the fame; for tho' Difputes may have been at firft eftablifhed and made ufe of in fome Univerfities with a good View, and for whetting the Underftanding; yet they have given occafion to many to cavil aboutthe moft weighty Truths; infomuch, that you fhall often hear them in publick Difputes, arguing with as little Refpect and Humility about the Being of a God, as concerning the vaineft and mof frivolous Entia Rationis, or Chymera's of the

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Brain; and you fhall fee them indifferently maintaining a Thefis of the Great God of Herrven a:d Earth, and immodiately after difconirfing of a Vacuum, or of imaginary Space ; and without any diftiaction of Reverence in the one Cafe or in the other. This infenfibly engages them in a fad $\mathrm{Cu}-$ fom of vainly ufing the tremendous Name of God very frequently, and without the leaft Devotion, and of making that molt fupreme and adorable Being, which ought not to be thought of, much lefs named without Emotion, the Object of their wanton Speculations. What Evils this has been the occafion of in fome, is very obvious to thofe who have experimented how much that Natural Contempt, which they feel in their Hearts (without Reafou indeed) for Divine Things, has been thereby increafed.

I leave it to thofe Gentlemen to whom the Stiperintendency over the Univerfities is intrufted, to find out Means, according to their great Wifdom, for obviating thefe Abufes; only, humbly offering it to their Confideration, whether the Weight of this great Affair, does not loudly call for an Anfwer to the foliowing Queftions: Firft, Whether it fhould not be forbid hencefonvards, that the Name and Attributes of the moft adorable Deity, fhould be made ufe of only as Means for exercifing young Underftandings, and furnifhing Matters for Difpute, with which Pbilofophy does, befides this, fufficiently abound. Secondly, That thofe Truths, concerning G o'd and his Perfections, in the Metaphyficks and Doitrine of Spirits, wherewith Youth are to be inftucted, be not any longer handied in Publick Difputations, but in Private Affemblies only, and (asit is the Cuftom in Divinity) after having poured out a Prayer to GOD, with that becoming Humility and Reverence which is due to the Great Lorm of all

Thingss;

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Things; the rather, becaufe molt commonly young People only (who are of an Age in which the Judgments are moft eality byaffed or corrupted, and the Paffons do mot prevail) are the Hearers of thefe Lectures and Difputations. By fuch Means we might begin to hope, that the Danger which arifes from this difrefpestful manner of Difputing, may be hinder'd from taking Root in young Minds; and that every body might be convinced by the pious Examples of the Academical Teachers, and reverend handing of thefe Matters, that Learned Men do likewife fear God; the contrary to which is maintain'd by many Atbeifss, and is one Method whereby they fiffe the Remorfes of their own Confcience.

Sect. XXV. The Fifth Inducement, Inattention or Heedlefnefs.

Besides what has been already faid, there is fill fomething more, which indeed does not carry Men into compleat Atheifm, and yet does very much contribute to hinder them from difcovering God in his Works; infomuch, that many People do, upon that Account, pals their Lives without obferving, at leaft without being convinced, of thefe weighty Matters; and that is a Natural Sloth and Cavelefnefs, or want of confidering, with proper Attention, thofe Things in which the Perfections of the Creator Jine out $\int_{0}$ brightly. We are all defirous to fatisfy our Curiofity, and therefore we earnefly contemplate, and oftentimes enquire into the Caufes of all thofe things which we take for Wonders; becaufe the Manner in which they happen is unkinown to us. If Comets or Parbelia appear, if the Sun or Moon happen to be eclipfed, how eagerly are they obferved both by Learned and

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Unlearned

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Unlearned Men; and yet we daily fee the Sun rife, and the Moon and Stars thewing themfelves; the Earth and Trees cover'd with Flowers and Fruits; Humane Creatures and Bealts procreating, and a thoufand other Wonders, and remain very indifferent towards them all, without dwelling long enough upon the fame, and obferving them with that Care and Judgment we ought, or turning our Thoughts towards the firft Caufe and Author of all.

Methinks one might conclude, that the frequently repeated View of fuch Things, each of which alone are wonderful in themfelves, fhould make fo much the ftronger Impreffion upon our Minds; and yet moft commonly we experience the contrary. That this fhould obtain in ignorant People, is not fo ftrange; but it is much to be lamented, that fuch a Heedlefnefs fhould many times be found in thofe, who do not want for good Underftanding, and who are defirous to pafs for Philofophers. One might likewife allow it in fuch as are not much accuftomed to value or fhew any Refpect for the Knowledge of a God, or the true Caufe of all Things; but that others fhould be fo carelefs in this matter, who are fo well convinced of the Importance of this Enquiry, that it does not fuffer them to be filent, but upon the leaft Occafion do continuaily argue for it, (infomuch that I have not been able to difcover the Doubts in which they were, or had been) is a thing that muft needs appear unaccountable to every body.
The Reader will not difpute the Truth of what I have here advanced, when I tell him, that I have been perfonaliy acquainted with fome Men, who were formerly thus heedlefs, and altogether infenfible of the Whorks of the Great Creator; but being afterwards brought to a more due At-
fention,
tention, were aftonifhed at themfelves, that thofe very Things which a Wife Maker and Powerful Ruler did, as it were, caufe them to feel with their Hands, which had been known to them fo long before, which they had frequently meditated upon in their Scudies, which they had read in the Works of other Men, and had often difcourfed of them with others; fhould not have carried their Thoughts up to a God, nor caufed them to feel in themfelves the leaft Conviction of his Being.

If Cuftom be the occafion thereof, which, becaule we daily fee fo many Wonders, makes us receive them without any Impreffion; one can only fay, that it is by fuch a Cuftom we become quite Blind, and wholly Infenfible.

Sect. XXVI. Means to prevent fuch Inattention.
The only Natural Means that I ever found effectual to render us more attentive to every Thing, is frequently to apply our felves to new. Difcoveries and Experiments, which appearing to us upon every Effay, to be New and Uncommon, do give us an occafion of obferving with Aftonifhment the Wifdom, Power and Goodnefs of Him that orders all Things after fuch a manner; efpecially, if we endeavour to wean our felves (which is here abfolutely neceffary) from this our natural Sloth, and continually join our Experiments, with thefe Obervations.

This is not the Place to take notice of another and true Caufe of our Blindnefs, which, in this refpect, is fo great as to hinder us from feeing the Perfections of G OD in the Works of the Creation, tho' they be daily before our Eyes; to wit, the aniverfal Corruption of Mankind; becaufe this is only to be remedied by Prayers, and by the

Grace of God itfelf, but no ways by natural Means, which is what we are here chicfly concerned about.

Sect. XXVII. Why we only make ufe of Proofs diawn from Natural Pbilofof̂hy.

From all that has been already faid, it may be inferr'd, that the exact and experimental Oofertions of what we fee in the World, is a demonftrative Means, not only to obviate fo many Caufes and Inducements to Atheifm, but likewife to attain to the Knowledge of a God and his Perfections by his Works : and let no Man think it ftrange, that in the following Difcourfes I make ufe of this Method, and not of other kind of Arguments, which are commonly called Metapby fical.

The Reafons that led me thereto are there:
Firft, Becaufe many learned Perfons have unanfwerably confuted the Atheifts after a Metaphyfical Manner; that is, fuch a one as is built upon Reafoning: The Proofs therefore, of this Kind, may be found in great abundance in their Writings.

Secondly, Becaufe Experience and Converfation with fome of thefe unhappy Philofophers, has taught me, that the Contemplations of Gon's Works, when one could bring 'em thereto, has induced fome among them to alter their Sentiments, who for many Years had withfood other Proofs ; becaufe the Sabtlenefs of their Underftanding feemed to furnifh them always with a Handle to difpute again? Metaplyyfical Arguments, and fo left them fill dinatisfied.

Finally, This Method will be allowed to be convincing, if not by finifl'd Atheifts, yet at leaft by unfettled and wavering Minds, who are

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not arrived at that Perfection of Wickednefs, as to deny the Divinity of the Holy Scriptures; becaule GOD himfelf has not thought fit to make ufe in his Word of artfully invented Philofophical Argumentations, and fuch as required more refin'd Judgments to underftand, in order to prove his adorable Attributes; but does for the moft part convince Men by his Works after this plain and fimple manner, which is obvious to all, thus manifelting his Love and Mercy to lis; fince thar notwithftanding the acutef Philofophers are forced to confefs in many Events, that they have advanced but a very little Way in the Knowledge of his wonderful Works, and flall never be able to fathom many of them; yet they are fo adapted to every body's, and even to the weakeft Minds, that we need only open, and lift up our Eyes, to be irrefragably convinced that there is a wife Maker and Ruler of all Things, without any farther Help of Hu mane Wifdom or Philofophy.

SECT. XXVIII. Becaufe GOD is pleafed to make ufe of this Way in bis Holy Word.
The Word of God does likewife give Teftimony to this fame Method in many Places of it. Thus we fee St. Paul makes ufe of the Creatures for a Demonftration of Go D's Eternal Exiftence; Rom. i. 20. The invifible Things of bim, from the Creation of the World, are clearly feen, being underfood by the Things that are made, even his Eternal Power and Godbead.

In the fame manner David relating the Works of GOD in a moft fublime and pathetical Strain, in feveral Verfes of the 104th P falm, proves from thence his great Wifdom, ver. 24. O Lord, how manifold
manifold are thy Works! in Widdom baft thou made them all.

Thus the Go d of Heaven dees not command us to feek for Arguments from the Depths of Philofophy, in order to fee his Power, but only to turn our Eyes towards his Works: Ifaiah xl. 26. Lift up your Eyes on high, and behold who hath created thefe Things that bringeth out their Hoft by Number; be calleth them all by Names, by the Greatnefs of bis Might, for that be is ftrong in Power not one fazleth.

His Mercies are alfo fhewn from his Actions in the 107th Ffalm. We likewife fee the Almighty himfelf in the Book of Fob, Chap. xxxviij, xxxix, $\mathrm{xl}, \& x \mathrm{xlj}$. making ufe ot Proofs taken only from his Works ; exhorting us, in many Places of his Hoiy Word, after the moft earneft Manner, thus to contemplate his Perfections in his Works. Thus we hear the Holy Ghoft in the rojth Pfal. ver 43. after having given a circumftantial Relation of the Actions of God, finally making this Conclufion: Who is wife and will oblerve tho Se things? Even they Jall underftand the Loving-kindnefs of the Lord.

From whence it plainly appears, that towards fuch wife underftanding, no feigned Hypothefes, but an Obfervation of Things themfelves, which can only be made by Experiments, is required; for which Reafon Men are wont even to this Time to beftow the Latin Term of Obfervations upon what we find out by Experience.

And fo great a Strefs is laid upon this Exhortation of knowing G o d by his Works, that thofe usho do not fudy them after that Manner, are pronounced Foolifla, and void of Underftanding ; Pral.xcij. 5, 6. O Lord how great are thy Works? and thy Thoughts ave very deep: a brutif/ Man knoweth wot, azither doth a Fool inderftand this; for which Reafon $_{2}$

Reafon, the not enquiring into the fame, is by the Spirit of God reckon'd among the Caules of $A$ theifm ; Pfal. x. 4. The Wicled, thro' the Pride of his Countenance, will not Seek after God: God is not in all his Thoughts.

SECT. XXIX. The General Proof or Demonftration of a GOD.

Af em er having fully comprehended all the foregoing, we might now have proceeded to the Contemplations of the World, and the Perfections of God, in the Compofition, Parts and Motions thereof, were it not that what follows may yet feem to require, that we fhould previoufly fhew after what Manner, from the vifible World, and that which we fee pafs therein, a Proof may be formed upon which we may rely and be affured, Firft, That there is a God, that is to fay, a Wife, Powerful and Gracious Maker and DireEtor of all Things ; And, Secondly, That the Bible (his revealed Word) is of a Supernatural and Divine Origin.

As to the Manner of demonftrating the Firf, I fhall, without entering into deep Speculations, like fome Philofophers, ferioully entreat every one, that with a compofed Mind, and divelting himfeif of his Paffions and Prejudices, he would filently fet down, and ferioufly confider, Firf, in cafe he fhould fee that,

1. Not one, but a great many,
2. And various or different
3. Things entirely ignorant, or tinknowing of all, and even of themfelves too :
4. Each of them frequently after a particular Manner,
5. However always unchangeably, and obferving the fame Rule ;
6. Do act and meive not once, but upon many Occafions and Times;
7. And not one of all them able to impart fuch Motion to itfelf;
8. Nor unlefs they thus come together of themfelves, can produce one fingle Effect without their own Knowledge:
9. In the Production of which Effect or Thing, if fome few Circumitances oniy, or oftentimes but one fingle one were wanting, it could not either be produced at ail, or at leaft not in its due Perfection;
10. Altho' that fame Effect fhould in itfelf be of great Ufe and Service, and fometimes of the utmoft Importance :

Could he imagine otherwife, than that all thefe things are formed to that End, and brought together with that Defign, to work fuch an Effect as we obferve to be produced by them?

And, Secondly,
Suppofing this firft to be true, fince thefe things are in themfelves ignorant and unknowing of all that paffes; whether every body muft not agree, that they are all produced, and made to concur by a wife and underftanding Agent, who had fuch an End and Defign in his View? And whether any one can perfwade himfelf that meer Chance, and unknowing Laws of Nature, or other Caufes ignorantly co-operating, could have Place herein, and could have directed and governed thefe things in all their Circumftances and Motions for fuch a Purpofe?

That this may be fhewn after a more plain and not lefs certain manner, let us apply to fome particular thing what has been juft now advanced in general, and as it were in an abftracted manner ; and let us fuppofe that in the middle of a fandy Down, or in a defart and folitary Place, where
few People are ufed to pafs, any one fhould find a Watch, fhewing the Hours, Minutes, and Days of the Months; and having examined the fame, fhould perceive fo many different Wheels, nicely adapted by their Teeth to each other, and that one of them could not move without moving the reft of the whole Machine ; and fhould farther oblerve, that thofe Wheeis are made of Brafs, in order to keep them from Ruft ; that the Spring is of Steel, no other Metal being fo proper for that Purpofe ; that over the Hand there is placed a clear Glafs; in the Space of which, if there were any other but a tranfparent Matter, he muft be at the Pains of opening it every time to look upon the Hand: Befides ail which, he might difcover in it a Hoie, and exactly oppofite thereto a little fquare Pin: He would likewife fee hanging to this fame Watch a little Key compofed of two Pieces, making a right Angle together; at the End of each of which there was a fquare Hole fo order'd, that one of them was exactly adapted to the little Pin in the faid Hole; which being applied thereto, a Chain would be wound up, and a Spring bent, by which means the Machine would be continued in Motion, which otherwife would be in an entire Reft: He might alfo find, that the other fquare Cavity, at the End of the little Key, was adapted to another Pin or Inftrument, which being turned this way or that, makes the Hand move fafter or flower. At the other End of this little Key there would be a flat Handle, which being moveable therein, might give him the Conveniency, that in the winding it up he fhould not be obliged to take hold of it at every Turn of his Fingers.

Laftly, He would perceive, that if there were any Defect either in the Whecls, Spring, or any other Parts of the Watch; or if they bad been

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put together after any other Manner, the whole Watch would have been entirely ufelefs.

Now the Queftion is, in order to form a kind of Demonftration from hence, Firft, Whether any Body can imagine, that fuch a Watch among other Purpofes, to which it might perhaps be ferviceable, was not likewife made for this End, that it fhould fhew the Hours, Minutes, and Day of the Month. Secondly, Whether he fhould make the leaft Scruple to admit it for a Truth, that fuch a Machine was made and put together by an underftanding Artificer for this very Purpofe, who when he made it himfelf, knew that, and to what End he had made it.

And Tbirdly, Whether it be poffible thathe can perfwade himfelf that this Watch, with all belonging to it, the Nicenefs of its Make, Figure of fo many Parts, and other Contrivances for fhewing the Time, could have acquired its Being and Form by meer Chance only, which operated indifferently one way or another, and without any certain Rule or Direction?

Or otherwife, whether he could expect to pafs for a Man of Senfe and Underftanding, if having found this Watch in a folitary Place, he fhould pretend to believe that it was not made by a skilful Workman, nor that its Parts were put together with Judgment ; but that there was a certain ignorant, and yet neceffary Law of Nature prevailing in the World, that had brought into a regular Method all the Parts, of which this Watch confifted, and had adapted each of them to the Ufe of fhewing the Time of the Day; and efpecially that fuch a Law of Nature was not only ignorant and unfenfibie of all that it did, or brought to pafs, but likewife, that no Bing, endued with any Wifdom or Underftanding, had eftablifhed and produced this Law at the Beginning, or in the leaft contri-
buted to the making the feveral Parts that compofed a Machine proper to fhew the Hours.

Once again, I befeech every one who thinks that he is at all concerned to know whether there be a God; that he would in his Retirement feriounly ask himfelf thefe Queftions; and confider how a Man, divefted of Paffion and Prejudice, would and ought to anfwer them.
We have dwelt the longer upion this Subject, becaufe, when the Reader fhall obferve us to fpeak, in the following Treatife, of Occult Caufer, Unintelligible Fatality, Ignorant Lawus of Nature, \&cc. he may always bear in mind, that we thereby mean fuch as we have been defcribing, namely, what have no kind of Knowledge in themfelves (which every one will readily allow) but likewife fuch as have acquited their Original, and difcharge all their Functions and Operations, without any wife Direction; which, as we have fhewn before, is the principal Difference between an unhappy Atheift, and thofe who Own, Love, and Fear a God, that he has not only created all things according to his Pleafure, but does with the fame Pleafure and Freedom preferve and govern them.
What has been faid above, concerning a Watch, is not lefs applicable to all other artificial Works: It will be therefore unneceffary to alledge any farther Examples of Mills, Ships, Sluices, Houfes, Paintings, \&cc. In all which, the Wiidom and Underfanding of the Maker does equally appear.

Now that our Confent may not be fufpended by thefe Evafions, namely, that thefe are no Mathematical Proofs (for befides that it would be cafy to trace the external Manner of a Matherhatical Demonftration herecin; let any Mathematician, not excepting the very beft, ferioufly teflect upon thic Structure of a Clock, upon the


Frame of the Stadt-houfe at Amfterdam, or thoufand orher Artificial Works; and if he do well and thoroughly comprehend the Relation which all the Parts bear to each other, and the Service they thereby render to Mankind, and at the fame time confiders that nothing of that whereof they are compofed, is endow'd with the leaft Knowledge or Judgment) let fuch a Man, I fay, fincerely declare, whether he be not as fully and ftrongly convinced, that they are not made or produced by Meer Chance, or lgnorant CauJes, but by Skilfuil Workmen, ArchiteCZs, and Engineers, as he is of any Propofition in Euclid. Yea, in cafe he were obliged to ftake his Life againft the faid Stadt-houfe, or the Value thereof (between which there is otherwife no comparifon) and to fay which was trueft, that this Stadt-houfe was built by Cbance, and had acquired all its Parts and Proportions without any wife Direction; or that it was made by an able Architect, with a view of becoming ufeful to Mankind; would he make any Scruple, think you, to declare for the latter?

Finally, We may apply all that has been faid above to demonftrate, that there is fuch a Wife, Mighty, and Merciful Being as God, in cafe we can make appear with as great (not to fay a much greater) Certainty and Conviction, from the Conftruction of the vifible World, and all that paffes therein, that there is a God and Great Creator, who in Wifdom has made them all; as we can fhew from the Structure of a Watch, and the Ufes that refult from the fame, that it has been made and put together by a judicious and skilful Workman ; and this we doubt not of doing in the following Contemplations, with all neceffary Clearnefs.

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## SECT. XXX. A particular Manner of Corroborating thefe Proofs in fome other Circumftances.

$W_{E}$ fhall not here enumerate other Kinds of Proofs, to thew the Defect of the Principles of thefe miferable Cavillers, which we have made ufe of upon fome particular Occafions in this following Work, becaufe we will not make this Preface too long. They that find them in fome Places are defired to apply them to others, where they think them to be of equal Force; tho', for Brevity fake, we may have there omitted them.

As for Inftance, in cafe the Reader be not fufficiently affected or convinced by what is faid of Living Creatures, Plants, Heavenly Bodies, and fuch like, let him imagine to himfelf that he faw the fame things imitated in little; and that tho ${ }^{3}$ they be incomparably more imperfect, yet they do in fome manner counterfeit the Works of Nature. To fpeak more plainly, let him fancy that he fees a Wooden Horfe put into a Motion by Springs and Wheels, a Wooden Bird flying (of which Hiftory has made mention;) or let him fuppofe that he fees in a little Machine, a gilded Globe, reprefenting the Sun, and other little Balls; which like Planets circulate about it; and then let him ask himfelf, whether he has Boldnefs enough to maintain, in the Prefence of Wife and Learned Men, that all thefe Things appear to him to be produced by meer Chance, or by certain unknowing natural Laws? And whether he has not a great deal of Reafon to believe, that fuch Sentiments would be juftly laughed at, even by the Ignorant themfelves? And after all, let him confider with how much lefs Reafon he entertains fuch Opinions; enitirely different from thole of all

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wife Men, concerning the true, natural, and unconceivably more perfect Things, which daily occur to his own, and all other Mens Obfervations in the Worid.

I have not urged this Matter in every Part of the following Sheets, where perhaps it might have been equally ufeful, becaufe I would not fwell the Work too much, which will otherwife be large enough ; but I have neverthelefs thought it my Duty to add this here, and to fuggeft this Advice to an Atheift who fhall take the Pains of Reading what I have writ, or will otherwife ferioufly contemplate the Structure of the World, fince I have often found it of Ufe, and a proper Means to bring thofe, who were otherwife fufficiently addicted to Cavilling, to a kind of Retrogradation, and to filence them for a Time.

Sect. XXXI. A General Proof, that the Scriptures are of a Divine Original.

The fecond Thing that is here neceffary to be enquired into, before we pafs on to the Contemplations of the World, is a certain Manner of proving (which we fhall upon fome Occafions hereafter infift on) that the Bible, as it is call'd by Chriftians, was writ by a certain Great and more than Humane Wifdom, and that it is of Divine Authority and Original.

To fpeak a Word or two of it here in general, I entreat my Reader feriounly and carefully to confider ;

In cafe he fhould meet with a Book, which for weighty Reafons was held to be Divine by other People, among whom there were a great many that he allowed to be very underftanding Perfons;
and fuppofing, that whilf he read and examined it, he fhould find,

Firft, That this Book did frequently make mention of certain Qualities of Natural Things (tho' with another View, and as it were en paffant) after fuch a Manner, as none but an Eminent, Wife, and Experienced Naturalift could do; whether he would not be obliged to conclude, with refpeef to that only, that fuch a Book muft have been writ with fingular Wifdom ?

Secondly, Suppofe he fhould be farther convinc'd, by irrefragable Proofs, that this Book did reprefent, with the cleareft Words, certain Properties of Natural Things, which at the fame Time it was writ (at leaft fo far as can appear to us) were not known to any living Perfon, nor for want of the neceffary Inftruments, could poffibly be known to any, whether it were to be doubted, that fuch a Book were writ with more than Hu mane Wifdom ?

And this being granted, from whom can we more reafonably conceive it to be derived, than from the Omnifcient Creator of all Things, to whom alone the things that were hid from every one elfe in thofe Ages, were known and open ?

And in cafe you defire to have this laft proved more ftrongly, we may fubjoin, Thirdly, That in fome Places of this Book is exprefs mention made of the Bounds and Limits of Humane Knowledge in future things; the Truth of which could not appear, but to the following Generations.

This being fo, as it fhall be proved hereafter, Can any but a Divine Power determine and limit,
by clear and plain Expreffions, that certain things fhall come to pals after many Ages? And when they have fo happened, muft not every one acknowledge, that it could proceed from no other than a Divine Original ?

Sect. XXXII. No Proofs can be brought of the Divinity of the Alcoran of the Mahometans.

What has been here faid concerning the wonderful Wifdom, that fo brightly appears in the Holy Scriptures, might truly be urged upon many Occafions againft the Alcoran of the Mahometans, where we fhould in vain feek for an Account of the Conftruction of the World, of which fo much appears in the Bible of the Chrifians: but fince thefe Papers are not fo much calculated for the Conviction of Mabometans as of Atbeifts and Unbelievers in general, it feems to me fufficient, juft to touch upon it here, without repeating it upon every Occafion in the following Difcourfes.

> Sect. XXXIII. A hort Account of what is propofed to be done in the following Work.

Now that we may reduce all that has been faid to it's End and Defign, and that we may convince every reafonable Perfon of the Perfections of God, this alone chiefly remains;

Firft, That we endeavour to fhew, that in the vifible World, or rather in that little of it that is as yet thorowly known to us by Experience, there does appear fo much Wifdom, fo much Power, fo much Goodnefs and wonderful Views, that the
the greateft Work of Art that ever was prepared by Men, is not comparable to it in the leaft.

And, Secondly, that we endeavour, by convincing Examples, to fhow the undeniable Truth of what has been faid above, relating to the Holy Scriptures.

We know very well that an Atheift may, upon fome Occafions, object againft this laft; that, perhaps, at the Time when the Bible was writ, Telefcopes and Microfcopes were in ufe, and, poofibly, brought to as great, if not greater Perfection than we find them in this prefent Age; by which Means they will endeavour to evade the Proof which we, in fome Places, have urged from the late Difcoveries thereof: But to anfwer them in one Word, let them confider with themfelves,

Fivft, That altho' we have Aftronomical Obfervations of many Ages paft, and with them the Defcriptions of feveral Inftruments then ufed; yet we do not find any mention made of Telefcopes, nor fo much as the Name of Microfopes among any of the ancient Enquirers into Nature.

Secondly, That the Inventers of thefe two Infruments, who lived in the foregoing Age, were known to all the Philofophers; no body being yet able to prove from any Memorials, that they were known to others before.

Thirdly, Whether it be credible, that the old Aftronomers or Naturalifts, if they had known the Things that have been fince difcover'd by thefe Optical Inftruments, would have tranfmitted down

Finally, And which is of the greatef Importance, let them ferioully confider, how prudent it is, in a Matter upon which their everlafting Welfare or Mifery depends, to fupport their Sentiments with a perbaps, or it may be, when, befides, every Thing that appears in Hiftory makes againft ${ }^{2} \mathrm{em}$.


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## Right Ufe of the Contemplation

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# W O R L D, 

FORTHE
Conviction of Atbeiffs and Infidels.

> C ONTEMPLATION I.
> Of the Vanity of all Worldy Things.

Sect. I. Every Man is placed here without his own Concurrence.
O begin therefore, by convincing not only thofe who are ftill under Doubts, (whether they be to be reckoned among the External Chriftians or not) but even the deplorable and obftinate Atbeif, of the great Neceffity there is to be rightly affured of the moft important Truths, and to correct thofe Miftakes which he has hitherto
hitherto admitted concerning every one of 'em; he is entreated moft ferioufly to reflect upon the Things which his own Experience informs him daily come to pals about him, and to ask his own Confcience, whether he don't find himfelf placed in this World without any Aft or Concurrence on his own Part? Whether it be in his Power to prevent his being one while Happy, Healthy and Strong; another while Unhappy,Sick and in Pain? Whether one Day does not follow another without his Leave, in which diversthings befal him, fome with, others againft his Mind, notwithftanding that he feels in himfelf a continual Defire influencing and governing all his Endeavours of obtaining Good, and avoiding Evil; which fometimes fucceeds, and at other times happens quite otherwife than he hoped for or intended, by Accidents which he could not efcape?

Whether he does not obferve, that what befals him is in common with other Men? But chiefly, Whether he does not fee that many Men die daily, and that very few of them feem to have any Thoughts concerning Death, efpecially whilft they are in Health? Notwithftanding that Sicknefles and Difeafes, by which they are fnatched away, oftentimes ftand in need of but few Weeks, fometimes few Days, yea even Hours, to change them from ftrong and healthy Men into dead Bodies or Carcafies.

Sect. II. And muff be convinced of the Unceraninty of his Life.

Further, whether he is not like all other Men, ignotant of the Time when Death fhall overtake him? Yea, at the End of one Year he fees a great many, who, in the Beginning of the fame, were alive and healthy (and fome of whom feemed

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to be ftronger than himfelf) to be fingled, as it were with Defign, out of the great Number of Mankind, and to be a Sacrifice to Death and the Grave; and that no body has been able hitherto to find out any Rule or Law whereby he could conclude, that this or that Man fhould die firft; unlefs perhaps fome very old or incurable Perfons, of whom indeed he might fay, that their Death was not far off: But even in fuch cafe, "tis not lefs true that he is ignorant, as near as they may feem to be to their End, whether he himfelf fhall not go before them: fo that every Man is forced to own, that his End may be near, as well as that of thofe whom he fees die before him; and who, whilf they were in Health, knew as little thereof, as he himfelf does now of his own Death.

S ec t. III. He muft likewife be convinced of the Vanity of all worldly Things with refpeCt to bimjelf.

N o w fince Death does fo furely overtake every Man, and yet the Time of it is fo uncertain; fince it deprives us of the Ufe and Enjoyment of all that is in the World; ought not every one that confiders thefe Matters, be convinced of the great Vanity that is in himfelf, and in all worldly Things with refpect to him? Foraimuch as he cannot enjoy either Profit or Pleafure from thence, but fo long as he lives, and how long, or how fhort that Life will laft, he knows not. This only he knows, that when he is arrived to a certain Number of Years, it cannot be very long: And he cannot fay, if he confiders every thing as he ought, that it is very defirable to attain to a great Age ; fince being deprived of the Ufe of all his Faculties, his Death is as it were anticipated thereby; for it leaves him neither Feet to walk, Eyes to fee, Ears to hear, or Teeth to eat with;

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and thus, while he is fill alive, he is by degrees thruft out of the Company of Men, and becomes, as one may fay, a living Carcafs.

SECT. IV. It is not even defirable to live here coirtinually, tho in Health.

No w if we fhould add to all this, that fuch as live long are not only fubject to the Infirmities of old Age, but often to very grievous Sicknefs and Pains; fome of which are entirely or almoit incurable, viz. in cafe he be deprived of all his Strength, and worn away by a Confumption, or tormented by the Gout, or Stone in the Bladder, by a cancerous Humour, or by the Falling-Sicknefs; to fay nothing of a thoufand other Diftempers, to which he is obnoxious, and which he may juftly apprehend, becaufe he fees fo many other Men affected with 'em ; would not he have a great deal of Reafon to wifh that merciful Death might fet him free from all thele, and from miferable old Age at the fame time ?

Now if one fhould fuppofe, which however fcarce happens to any Man, that the Evils of old Age do not render his Life a Burden, and that he fhall enjoy even as long as the World itfelf fhall laft, the fame Strength both of Body and Mind as he did in his Youth; yet when he feriounly confiders every thing, this very State and Condition, far from being defirable, muft appear to him very deplorable: For, Firft, in cafe his Native Country fhould be ruined and laid wafte by Earthquakes, Inundations, or War, he cannot efcape Mifery and Poverty as well as the reft: And how many Years of tedious Labour are there required to repair what he has loft, fo as to be able to enjoy the fame the remaining Part of his Life? And having fcraped it up again with Trou-
ble, muft not this Man, who is to live as long as the World ftands, be always in Pain and Fear of lofing it, either after the fame, or fome other manner? At leaft fince the World itfelf is fubject to thofe Revolutions with which the Hiftories of all Ages have acquainted us. How few Governments are there that have been able to keep their Footing for feveral Ages together, and of which the Inhabitants have not been driven or rooted out? And on the contrary, how many can we reckon, which after they have rifen to the higheft Degree of Glory and Grandeur, yet at laft have found their End in an entire Deftruction? So that even fuch a long and healthy Life, as we have been fuppofing, would only be a miferable Pilgrimage for him, in which, when he had hardly come out of one calamitous State, he would be in a continual Apprehenfion of another.

And if no evil Accident fhould overtake him (which is not to be conceived) what Pleafures are there in the World that are lafting? So that he can expect nothing elfe but that fuch a Pleafure, which whilft it was new, was very agreeable to him, either by long Enjoyment (as Cuftom renders all things) would become firlt indifferent, and afterwards infipid; or at beft, by the Uncertainty which is vifible in all things, would foon forfake him: Had he a Wife, Children, and good Friends, which are the moft comfortable things of this World, they would all die before him; and he would every time be fubject to that Heartbreaking Sorrow of lofing thofe deareft Treafures were they to live long? So foon as they are overtaken by the Infirmities of o.d Age, they would only be continual Objects of Pity, and confequently of Grief to him : Yea, every Thirty, Forty, or at leaft Fifty Years, he would meet with and be obliged at every Turn to enter into new Friendfhips and a new Acquaintance; or to converfe with unknown People, whofe Inclinations he muft fudy and learn to know again, to the End that he may, whether he will or no, conform his own to theirs, if he expects to enjoy any Favour or Kindnefs among them, and not to be excluded from their Converfation as a ftiff and illnatur'd Fellow: And if he has had Children, of which even a numerous Pofterity are remaining, what Friendflip and Love can he promife himfelf from them? Who, tho' they were defcended from him, would be yet in a remote Degree of Relation; fince Experience teaches us, how foon all Kindred, after a few Defcents, grow frange to one another: And I have often thought, if Adam himfelf, our common Father, fhould return again to the World, and ftay here fome Ages, whether any of his Pofterity would receive him friendly? Efpecially if he fhould pretend to make ufe of that Right, by which he alone would be entitled to, the Property and Government of every thing: Would not the moft Part, if not every individual Man, think that he did them Wrong, and fee him, with concern, taking Poffeffion of their Habitations? Now in cafe the Refpect and Love which every one owes him, could not fo far prevail, as to render a Father happy among his Pofterity, what could be expected by a Man in fo great, tho' ftrong and healthy old Age, who would be no longer confidered as a Father, but as a remote Kinfman, whofe Pedigree could not be traced, or perhaps even as a meer Stranger ?

## $\mathrm{S}_{\mathrm{ECT}}$. V. The miferable Condition of the Atheifts.

Since then a long and healthful Life, which otherwife feems to be the moft defirable Bleffing upon Earth, is fo vain, a Man cannot be render'd happy thereby; let any one who doubts or denies the Perfections of a God, extend his Thoughts farther; and fee, Firft, how dreadful fuch a Life would be to him in particular, even tho', according to his miferable Philofophy, he had no God to fear, and that all Things were directed either by meer Chance, or by irrational, unknowing, and neceffary Caufes.

For from fuch Principles as thefe he muft grant, that in cafe he were unhappy, nothing but Chance could relieve him; if he were happy, fince the Caufe thereof is accidental and ignorant of its own Effects, he muft live in a continual Fear, that every Moment may change his Condition : And not to reckon up all the Circumftances that may evince the fame, what is there in the World from which he can expect the leaft Happinefs or Advantage with any Foundation of a reafonoble Hope, and from whence he can expect any Love or Good-will towards him, let him behave himfelf as he will? And that Man's Life muft be very miferable, who is neither Loved nor Efteemed by any body : Suppofe he were a Prince that governs a whole Nation, how can he think, without great Uneafinefs, that it is by meer Chance his Subjects obey him? If he be a Subject, and lives under the Command of a Superior; muft he not tremble when he confiders that it is accidental only that his Goods are not foln ; his Houfes burnt ; his Wife and Daughters ravifhed; his Sons carried into Slavery, or murdered; and that it is by meer Accident that dence, and that Chance, as Chance, may at all times produce, indifferently, this or that Effect; muft he not tremble when he looks upon the Earth, which, if every thing depends upon Chance, may immediately begin to burn under him, or may open her Mouth and fwallow him up? And if he looks into the Air, muft he not imagine, that it is purely Accidental that he is not deftroyed by Storms and Tempefts, by Thunder and Lightning, or that Rains and unfeafonable Weather do not ruin all his Plantations and Poffeffions?

In vain, allo, will he endeavour with fuch like Conceits to avoid all thefe Terrors; tho' he fhould admit that it was not a meer Chance, but an unintelligent Neceffity which governs the Univerfe by certain unchangeable Laws; for fince according to thefe fuppofed Laws, he fees feveral interfering Operations of Nature come to pals, whilft he fees the Air one time Calm, another time Tempeftuous; whilft he fees the Wind from the South, and then again from the North; the Sea Ebbing and Flowing; one Seafon extreamly Hot, another very Cold, and the like; mult he not confers (tho' he fhould fuppofe that all this did neceffarily happen) that it will be as terrible to him as Chance itfelf; to him who knows not when a contrary Effect flall be produced according to thefe fame Laws.

> SECT:

SEcx. VI. The Advantages which they that Love and Fear a God enjoy.

Lastly, let him tell us fincerely, whethre in refpect to all that has been faid, he does not think thofe Perfons to be unfpeakably more happy, who are convinced that they depend upon an adorable Creator; by whofe Wifdom they have been fo wonderfully formed; whofe Power has render'd fo many of his Creatures fubfervient to their own Well-being ; who has given them the Capacity to enjoy the fame with Pleafure and Thankfulnefs; who being Wife and Mighty can preferve them, and being Merciful will preferve them; that without his good Pleafure, none of the aforefaid Evils come upon them; infomuch, that if He be with them, nothing can be againft them; who, befides the good Things of Nature which He is largely and conftantly dealing our to them, makes known his Word to them; and to remove all their Doubts, has ftamp'd it with irrefragable Marks of its Divine Original ; who has there revealed his Will, purfuant to which He will be fought after, ferved, thanked, and praifed by them; who has there manifetted his Love to them, which paffes all Underftanding; and has likewife promifed to render them eternally happy after Death.

SEct. VII. It is therefore neceffary to feek for the Demonftrations of $a$ God, Pfalm xiv. I.
Now fince every Atheift muft confefs, that his own Principles (unleís he will deny them too) do render him unhappy, and caufe him to live in continual Appichenfions; I leave him to judge, whether a Man muft not be a very abfurd Perfon,

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and, as it were, an Enemy to himfelf, who notwithftanding that he fees the contrary Opinion maintain'd by many others, of whofe Wifdom he has no Reafon to doubt, yet takes all the Pains imaginable to perfwade himfelf that there is no GoD; and therefore, whether the Holy Penman of the firft Verfe of the 14th If alm, has not a great deal of Reafon to give fuch a Man the Name of Fool, who tho' he can never prove his Opinions, yet with all his Heart, and all his Soul, endeavours to make himfelf miferable, and to run headlong into a State full of Terror and Di Atraction ; that is to fay, into the Condition of an Atheift?

For a Confirmation of the Truth of what has been here faid, I could farther add, that I myfelf have heard one of thefe miferable Wretches, whofe Judgment feemed capable of every thing but acknowledging a GOD, lament the Unhappinefs of his Condition with great frankners, and in the moft pathetick manner.

And I can't forbear faying, that the Remembrance of it does ftill very much affect me whilft I am now writing it, tho' long after his Deceafe.

To proceed; If any one has a true Love for himfelf, and does but hear that it is maintained by many Perfons for an uncontroverted Truth, that there is a Wi $\int_{e}$, Mighty, and Merciful Creator of the Univerfe, who can render all thofe that endeavour to know, ferve, and honour Him, happy, both now and for ever ; and thofe that deny or defpife Him, miferable to all Eternity: 1 fay, that Man muft be in a very defperate Mind, if he does not think it to be of the utmof importance to enquire into the Force of fuch a Proof, upon which fo many wife Men, living and dying, do entirely depend. -

Sect. VIII. The Tranfition to the following Contemplations.

I Hope then, that among thefe unhappy Men there may be fome found, who, in order to free themfelves from thefe fad Uncertainties (for no Atheift ever had any Certainty of his wretched Notions) will think it worth their Pains, ferioully to weigh the Arguments that may contribute thereto; and we befeech fuch to pafs on along with us to the following Contemplations; and perhaps the Great God of Heaven and Earth may vouchfafe (as we heartily beg of Him for their Sakes) to open their Eyes, to the End that they may fee, and be fully convinced of the unexpreffibly amiable Perfections of his Glorious Works.


CONTEMPLATIONII.
Of all tbat is Vifible, and of Ourfelves in particular.

SECT. I. It is neceflary to call upon $G O D$ at the Beginning.

$B$Efore we come to the Thing itfelf, and from the Vifible Part of the World endeavour to fhew, that in the Structure thereof, the Wifdom, Power and Goodnefs of the Great Creator fhines out with more Brightnefs and Luftre, than to admit of a Comparifon between any of his Works, and thofe of the moft skilful Artificer

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that ever was. Let it not feem ftrange to any one, that in this Enquiry, which perhaps may be thought purely natural, we affirm it to be abfolutely neceffary, firft of all to implore the Great Creator and Governour of all Things, with the deepelt Humility, that He would be pleafed to enlighten our Underfanding (which in itfelf is fo dim) that we may view and comprehend the Beauties and Wonders of his Works; and farther, that thro' his Goodnefs He would vouchfafe to purify our Hearts from all contradicting Paffions and unreafonable Notions refulting from thence; fince it is not unknown to any one who has obtained this Grace, that he can, as it were, feel and difcover, in innumerable Things, with an entire Conviction of his Confcience, the adorable Maker of them; that many things have often prefented themfelves to his Mind formerly, and have been rightly underfood and comprehended by him, without once exciting him to look up to the firft and chief Caufe thereof: So that it plainly appears from hence, that neither the Penetration of his Judgment, nor the Things themfelves, are fufficient to lead him to a right Contemplation, without fome farther Affiftance befides them. And in cafe an Atheift flould only confider thefe Convictions as Hiftorical Truths ; yet at leaft he muft acknowledge, that in a Matter of fo great Importance, and upon which his everlafting Happinefs or Mifery depends; it would do him no Harm, according to his own Principles, if, like the Athenians, he fhould invoke the Affifance of a GOD, as yet unknown to him.

SECT. II. GOD's Eternal Exiftence proved from the Creatures.

Now to proceed to our intended Work : Since our Defign is rather to offer or propofe the Proofs of the Pefections of God, that is to fay, of his Widdom, Power, and Goodnefs, by way of Conviction to unhappy Atheifts, and doubting Minds, than to prove his Eternal Exiffence, that being not denied by any Atheifts who own an Eternal Being, as far as I know; yet if there be any among them fo blind as fill to doubt, whether this alfo can be demonftrated from his Works, we fhall likewife endeavour to give them full Satisfaction herein, and to produce unanfwerable Proofs thereof in this very Place, before we proceed to the other.

Let the Atbeift then ask himfelf, upon the Suppofition that there was no Eternal Being, that is, in cafe there ever was a compleat Nothing, when there was neither Creator nor Creature, nor any thing whatever that had an Exiftence, whether he mult not be convinced, that in all Eternity the fmalleft Thing whatever could not come to exift; and that fuch a Nothing muft remain and continue to infinite Ages a meer and fimple Nothing?

So that not only from thefe vaftly extended Heavens, and their unfpeakable great Lights and Bodies, but even from the moft tender Leaf or Grafs, from the moft contemptible Stone we tread upon, and from the fmalleft Grain of Sand, this Affertion can be irrefragably maintained; fince if ever there was a compleat Nothing, the very meaneft of all thefe could never have been produced, or made to exift in an Infinity of Ages.

## Sect. III. The fame proved from Romans i. 20 .

$A_{f t e r}$ the fame manner we fee the Apofle Paul proving God's Eternal Pouter, whereby He Exifts of himfelf from all Ages, and his Divinity, whereby he is diftinguifhed from all Creatures that have had a Beginning: And thus fpeaking in his Epifte to the Romans; Ch. i. v. 20. The invifible Things of hime from the Creation of the World are clearly feen, being underftood by the Things that are made, even his Eternal Power and Godhead; Jo that they are without Excufe: And fhewing likewife that in naming the Creatures in general, he excepts nothing out of 'em, how fmall foever it may be, which by its Exiftence is not capable of convincing, with the utmoft Certainty, every one that has not quitc loft the Ufe of his Reafon, of God's Eternal Power and Divinity, that is, among other Things, of his Eternal Exiftence.

SECT. IV. The Contemplation of Ourfelves ingeneral.
Now as this Contemplation of all Creatures in general, after the aforefaid manner, is a Te ftimony to every Man's Confcience, that there is an Eternal GOD; folikewife will every Man that only views the Frame and Conftruction of himfelf, (and confiders who he is, and whereof he confifts; how he is come info this World and preferv'd therein,) from thence be convinced of the Wifdom, Power, and Goodnefs of fuch a God, without hardly confidering any other Particulats, tho' we hope alfo to account for them hereafter.

He , therefore, who has hitherto denied or doubted of fo weighty a Truth, let him turn his Eyes and Thoughts firf upon himfelf only, when

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when he cannot but confers, that he has a Body, of which, being in Health, he is capable to move fome Parts, fuch as the Hands, Feet, Eyes, U'c. $^{\text {c }}$ arbitrarily, and according to his own Pleafure ; and again (which is very remarkable) that his Will has little or no Infuence or Power over other Parts: Thiths his Heart beats, lis Blood circulates, his Stomach and Bowels are moved; the Humours and Fluids, which compofe fo great a Part of his Body, produce feveral Effects in him, without his being able cither immediately to hinder or promote their Operation: Moreover, he finds that he Underflands, Wills, Reafons, Loves, Hates, Fears, Hopes, and (in one Word, that Philofophers commonly make ufe of to Sum up the whole) that he Thinks.

## $\mathrm{S}_{\mathrm{EC}} \mathrm{T}$. V. The Coritemplation of our Body, which is Earth.

Now upon enquiring firtt into our Body, we are conyinced by certain Experience, that the fame confifts of the Food we ure, fuch as Herbs, Fruits, Corn, Flefh, Fifh, Water, and the like. The Beafts have likewife their Food; and tho thefe eat one another, yet the Food of moft of them confifts of Plants and Water ; for as for Foffils, Metals, and fuch like, we do not yet know that they ferve for Food to any Creatures; and tho' they flould, yer the following Proof will remain in its full Force.
Now all thefe Plants fpring out of the Earth, and being fown, feem to draw their whole Subflance from Earth and Water, excepting only what Air, Light, or fuch like Matter, may contribute thereto; which Mixture of all together, becaufe we meet with it in all fruifful Soils, we fhall hereafter, for brevity fake, call by the common Name of Earth.

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From whence then a Man muft finally conclude, that the Matter whereof his Body confifts, is nothing but the Water he ufes in his Drink, together with an altered and difguifed Earth, which firft becomes Plants, and afterwards is turned into the Subftance of his Body.

Now if all this does not appear clearly enough to him, let him fuppofe the Perfon of a Man, who having been before very fat and heavy, has loft fome Pounds of Fat by Sicknefs; if fuch a Man being reftored to his Health, and ufing no. other Food than Bread and Water, fhould again attain to his firf Weight ; whence proceeds this his new Flefh, but from the aforefaid Bread and Water ? but more efpecially, if he confiders the Smallnefs of his Body in the very beginning, which when his Mother firft conceived him, was fcarce of the Weight of half an Ounce ; tho' the fame Body afterwards, firft by the Nourifhment it received from the Mother, and afterwards what it took in itfelf (both which, with refpect to the Matter of it, can be called nothing but Earth) grows up toa Man of fo many Pounds weight : And will he then fill doubt, fince all this Nourifhment confifs of Water and Earth only, whether his whole Body, in its utmoft Extent, is any thing elfe but a metamorphofed or tranfubItantiated Earth?

## Sect. VI. That the Body does not Think.

Having now difcover'd thefe Thingsconcerning his Body (that we may advance a little farther) let him fuppofe himfelf fitting with another Perfon at Dinner; could he think that the Bread, Flefh, Fifh, Beer, Wine, © $\mathrm{E}_{\mathrm{c}}$. that are eaten and drunk, fhould firft become Nourifhment,
ment, and afterwards being turned into his Body (or rather, that a quantity of Earth, from whence this Nourifhment proceeds) has the Capacity to judge of, and to underfand his, or another Man's Difeourfe; or can comprehend the Demonftration of a Propofition in Euclid? or lat him confider, whether a skilful Chymift and Philofopher could ever juftly fancy to himfelf, that he was able to produce, out of fuch Food or Nourifhment, a folid or fluid Body (befides which two, no third can be fhewn) that can Think, Reafon, and Difcourfe like a Man? Now I cannot bring myfelf to fuch a Belief, that there ever was any Man, who defired to pafs for a Perfon of the leaft Senfe, capable of advancing fuch Notions, and intrenching himfelf in the fame, againtt an approaching Eternity.

## SEC T. VII. The Soul demonftrated.

A l 1 this being duly weighed, can a Man make any other fort of Conclufion, than that his Food, confifing of Earth and Water, is the Subftance of his Body ; and that nothing of thofe, or of any thing elfe praduced by thofe, (nor confequently his Body) is capable of Underftanding, Reafoning, or Tbinking.

And yet he is affiured, and plainly convinced, that he both Underftands, Reafons, and Thinks: This therefore is an irrefragable Proof that there is fomething elfe in him befides his Body, which Underftands, Reafons and Thinks; fo that he does thereby know fo much of himfelf, as that he is compofed of two diftinct Subftances, viz. of a Body which is Earth, and of fome other thing befides his Body, which other thing Underftand!, Reafons, and Thinks: This laft is called the Soinl;
and therefore he knows that he does confift of a Body aid Sorul.

## SEct. VIII. No Main proceeds from binfelf, nor from his Pcrents, but from another.

Beinc come thus far, and knowing what he is, let a Sceptick, or an Atheift, go a little farther with us, and endeavour to find out how the came into this World, and how he is here fupported.

And that he may bring himfelf to confider the fame experimentaily, let him examine himfelf, and fee, if it was in his Choice or Power to be here or not, whether he would choofe to be formed Sick or Healthy, Blind or Seeing, Streight or Crooked: To all which, without doubt, he will anfwer, that he would rather be form'd with the good Qualities. On the contrary, let him by his own Experience enquire, whether he be not placed here without the leaft Act or Concurrence of himfelf, and entirely without his own Knowledge, in the Condition wherein he finds himfelf, and wholly uncapable of beftowing on himfelf more or fewer Advantages of Nature: Confequently then, he muft be convinced that he does not proceed from himfeif, but from another.

But fuppofing it fhould be objected by fome body (who being wavering and full of Doubts, and unwilling to confent to what has been here advanced, leaft he fhould be forced to acknowledge a God) that his Parents were, by way of Procreation, the firf Caufes of his Exiffence in this World; which at firft fight carries fomething fpecious with it: yet if he will be pleafed to penetrate farther into the Matter, he cannot refufe believing, that his Parents, as well as others, owe their Beginning to that defire of propagating
their their Species, which is naturally implanted in att Creatures; without any Certainty atthe fame time, or thought of the Confequences of fuch an A\&t. And muft he not, moreover, confefs, that none of 'em all were capable of knowing or faying whether it frould be a Man or Womath, a deformed or well-fhaped Child, that was to be produced? Yi.a, after the Birth, does it clearly appear to eicher of the Parents, how the Body of fuch a Child is framed with refpect to its Veins, Nerves, Flefh, Bones, Humours, and other Parts?

Now if all this bebrought to pafs without the Knowledge of the Parents ; if they be entirely ignorant of the Compolition or Structure of their Child, how can he look upon them as the true Caufe of his Being and Subfifting? Can one juft ly hold that Perfon for the Artificer, or the real Caufe of any Machine, who is forced to own that he does not know any thing of the ConftruEcion, nor how it came to be fo made? and yet more, who did not fo much as know even whether it was made by him, tho he did all that lay in his Power towards the Production of it?

And fince he cannot judge that his Parents have contributed more to him than others do to their Children, muft he not own that it follows from thence, that he is placed here entirely without his own Concurrence, and without being able to prove that his Parents are any thing elfe but unknowing, and confequently no true, but, at the moft, inftrumental Caufes only of his Exiftence?

Moreover, to the end that we may obviate all Evafions, and demonftrate undeniably that he cannot be produced by his Parents as true Caufes, lef him recollect, that befides his Body there is a Soul of which he confifts, which has been already fhewn to be entirely different from his Body. Now all that could happen towards his

Production on the part of his Parents, feems only to have refpect to his Body, and confifts in nothing more than in the Communication of the Semen Corporeum, which likewife has its Original from Food and Nourifhment; and therefore, according to what has been proved above, is nothing elfe but metamorphofed Earth and Water. Now this Earth and Water, or any thing elfe that proceeds from them, does neither Underftand nor Think, and yet he himfelf does both; for which Reafon he ought certainly to be convinced, that he, as a Man, that is to fay, as an intelligent, rational, and thinking Creature, can by no means owe his Being to his Parents; and fince he cannot be the Caufe of himfelf neither, he muft therefore, as well as all his Forefathers, have been brought into the World by fome other Being.

I have here in the Beginning, that I might not feem to argue too acutely, paffed over thofe modern Oblervations, by which it is pretended, that the Humane Body draws its Origin from a Stamen or Fundamental Principle, in which the Members are rolled upas in a Clew or Ball of Thread; which afterwards, by the help of Nourifhment, is filled up and unfolded to a Vifible Body. The Reafon is, becaufe the Proof which we have here in view, would fill remain of the the fame Force. Firft, Since this Stamen, how fmall foever it may be, whilf it continues unfolded, is neverthelefs a real Corporeal Subftance. Secondly, Becaufe it is not yet proved, that this Stamen does not proceed from the Fluids of the Father or Mother, or of both, and therefore does likewife confift of difguifed Earth. Thirdly, By what Caufe focver this Stamen is produced, it cannot be denied, that when it is quite unfolded into a Vifible Body, it is neverthelefs a Corporeal

Subftance, and fo remains. Now that fuch a Subftance can Difcourfe or Think, no body that would pafs for a wife Man will rafhly affirm ; nor do I believe neither, that there was ever any one found who would perfift in this Notion, That we ought to afrribe the true and real Caufe of the Formation of our own Stamen, or of any other Humand Body, to our own Knowledge, or to that of our Parents. Whoever, therefore, does any thing ignorantly and unknowingly, cannot, as we lave faid before, be confider'd any otherwife than as the inftrumental, but by no means the true Caufe of any Effect: From whence it follows, That the Conclufion muft remain as it did; namely, that neither our Parents, nor we ouifelves, are the true Caufes of our Exifting bere.

## SEC T. IX. That our Support is from Another.

Now after the above-mention'd Difcoveries, it may eafily be made appear to every Man, that as he is not placed here by his own Power, fo neither is he fupported by the fame: For if he were, he might at leaft provide Food and Nourifhment for himfelf: But can he make the Sun to rife, which caufes every Thing to fpring out of the Earth? Can he bring down a Drop of Rain from Heaven, which renders the Ground fo fruitful, and which likewife muft ferve him for Drink? Can he communicate an Exiftence, and the neceffary Properties to one fingle Ear of Corn, or to the fimalleft Blade of Grafs, in order to feed himfelf, and thofe Creatures which he ufes for his Nourifhment? But to go yet farther, fuppofing he had Food in abundance, can he tell after what manner his Body is thereby fupported? Or does he know where that which refrefhes his Body remains, as foon as it has paffed thro' his Stoliach and
22. The Religious Pbilofopher.
and Bowels, and how his Food is turned into Blood and other Juices, and how they again are converted into fuch different Parts, of which his Body confifts? So that here again, he can conclude no otherwife, than that all this furpafies his Power, and that it is not by himfelf, but by fome other Being, that hee exifts and is upholden.

SEct. X. And this other Being, either knows, or is ignorant of what be doeth.

Now being thus far affured from what has been fajd, that a Man is not produced by himfelf nor by his Parents, but by fome other Being, by which he is likewife fupported; I leave any one to judge, whether he can live in a perfect Tranquility, without endcavouring to know what kind of Being it is, by which he is made and preferv'd; fince I cannot think that he is fo infenfible, or folittle affected concerning thofe Things that relate to his own Happinefs or Mifery, as not to look upon this to be an Affair of the utmoft importance.

If then he will endeavour with us to enquire into thefe Matters, he muft at leaft acknowledge for an undeniable Truth, that the Caufe by which he is here placed and fupported, does either know and underftand its own AEtions, or elfe is entirely ignorant of them ; that is, he muft either agree with the wifert part of the World, that there is a Goo by whom he is made and preferv'd, who knows what he did, and what he daily does, with refpect to him; or elfe he mult endeavour to perfwade himfelf, purfuant to thofe Principles of unhappy Atheifts, (which have never yet been demonftrated) that he was brought into the World by a meer and ignorant Chance, or by a neceflary Confequence of the Laws of an unknowing
knowing Nature: One of thefe muft be undoubtedly true.

> Sec T. XI. That our Maker and Preferver is Wife, Mighty and Merciful.

Now in order ferioufly, and withour Paffion or Prejudice, to confider fo important a Matter, and to know which of thefe two Queftions are to be received for Truth; let him fuppofe, that he were to be brought into a Room, where he flould fee feveral Clocks and Watches that have been adjufted with all the Skill and Perfection the Artificer could exert, fo that they went very true and reguiar; and then let him ask himfelf, whether he thinks thofe Machines could acquire their Exiftence and Aptnefs to perform their feveral Functions, without the Concurrence of the Skill and Judgment of a Workman, and only by Caufes that were ignorant of the Effects they produced, fuch as meer Chance, or neceffary Laws of Nature? and whether he would not judge that any Man, who fhould undertake to deduce fuch Conclufions from his own Philofophy, were not quite out of his Senfes?

After having maturely confider'd all this, let him proceed farther, and inftead of Clocks, let him caft his Eyes upon the Frame and Conftruction of his own Body, or upon that of Beafts, Birds, Fifhes, Plants, and other Wonders of Nature, and think, fince a good Clock does undoubtedly prove its Workman skilful, whether in each of thefe laft mentioned Things there does not appear an Art incomparably greater than that which fhews itfelf in the very beft Clocks? forafmuch as it is mof certainly true, that the beft Artificer in the whole World, is not capable of producing even a Moufe or a Fly, a little Flower

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or a Plant, tho' never fo fmall, in fuch a Perfection as we fee them daily appearing. Let him therefore filently examine himfelf, whether all his Atheiftical Arguments can bring him to embrace thefe miferable Notions for Truth with Tranquility, and without a continual Remorfe of Confcience, viz. that he who made his Body, and all thefe Things, after fo wonderful a manner, and out of fuch improper Matter as the Earth appears to be for fuch a Purpofe, fhould be fo far void of Wifdom and Underfanding, as not to know after what Manner, nor to what End, he had made the fame?

Now fince an unhappy Atbeif feems to be unavoidably obliged by all thefe Things, to acknowledge that his Creator is wonderfully Wife; fince, moreover, the Manner whereby he is preferv'd, feems to convince him, that this his Preferver is not only Wife, but alfo Mighty and Merciful ; having moft bountifully provided fuch a great Body as the Sun to give him Light; the Air furrounding this whole Earth, for Refpiration; fo great a quantity of Water, to affwage his Thirf; fuch a number of Plants and living Creatures, to fatisfy his Hunger, and to refrefh him ; and fo many other Things for other Ufes, without any Co-operation on his Part, and fuch wonderful Faculties for the Enjoyment of them all: Let him finally confider with himfelf, what he ought to expect, even in his own Judgment, from the juft Wrath of this his Maker and Preferver, in cafe he continues to deny his Wifdom, to defpife his Power, and to be ungrateful for his Mercies; and in order to free himfelf from the Obligations he lies under to Providence for all thefe good Things, if he continues to afcribe them all entirely to infenfible and ignorant Caufes.

## SECT. XII. The Tranfition to the following Contemplations.

I can fcarce think it poffible, that there fhould fill be an Atheiff fo deplorably obdurate, after having weighed all thefe things moft ferioufly by himfelf, as to dare to own, that the Confideration thereof does not make him uneafie ; and in cafe there fhould be any that had fo far abandon'd themfelves to their feducing Paffions, yet it is not to be imagined, that all of 'em have fo greatly renounced their Reafon, as not to think it worth their while to pafs on with us to the Contemplation of the Works of the great Creator in the following Difcourfes; or that among fo many Particulars and Wonders, which they will there meet with, there fhould not be one fingle one, fufficient to make them fee their Error, and to give them a convincing Proof of a Deity fhining out fo brightly from thence. This I can fay experimentally, that by the Meditation chiefly of what has been here offer'd in thefe two firft Contemplations, an unhappy Perfon, whom I had formerly often befought, while he was in good Health, that he would ferioufly weigh thefe Things by himfelf, (and who was wont, even till a few Weeks before his Death, where-ever he could fpeak his Mind freely, to ridicule all fuch as acknowledged and ferved a GoD) was by Go d's Grace brought over to better Thoughts, and to a Conviction of his Exiftence, as he confeffed to me with his own Mouth in his laft IInefs.
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## Contemplation III.

Of fome Particulars in the Mouth.

Sect. I. Concerning the Teeth.

Tbegin then ; let us firf contemplate our own Body, and all the wonderful Structure thereof; which, tho' the moft part of our Food, as Bread, Flefh, Fifl, ©̌c. confifts of folid Bodies, cannot be nourifhed by them fo long as they remain fuch, and are not firft converted into Fluids; wherefore a Means was requifite to turn thefe folid Bodies into a liquid Matter, and even fuch as fhould be proper to peferve and noutifi us.

For this Purpofe there are Teeth planted in our Mouths, of which thofe that ftand foremof are fharp and cutting, in oider to bite off a Part of that Food which is taken in, whofe femicircular Figure is wifely adapted to a juft Meafure of the Piece to be bitten, and fo as to be afterwards chewed with the moft Conveniency, as every one may experience who makes his Biting greater or fmaller. The fecond Sort are thofe that are called Dog-Teeth, and thofe are more pointed than cutting, and feem to be particularly defigned for fomething that is tougher and harder, and which cannot eafily be penetrated by the former, in order to hold it faft, and fo to divide it from the other Part.

Does there not appear a wife End in all this ? Why are not the following Teeth, which are call'd Grinders, of the fame Figure? Why are they flat and
and broad, and uneven with Cavities and Pronuberances, as if Nature intended, that what was bitten off by the foremoft, fhould be beaten (mall and ground by thefe latter, to which their Uncrennefs contributes; as it is in fome Mill Stones that are made uneven on purpofe, in order to grind the better? If this is done $\mathrm{b}_{\mathrm{y}}$ Chance, why don't the Grinders ftand foremoft, and the ForeTeeth in the inward Part of the Mouth, which would certainly render biting and chewing rery uneafie? How happens it, that almof all the other Bones are clad with a tender and fenfible Membrane, but the Tceth, fo far as they ftand out of the Gums, with none; unlefs it were to aroid that Pain, which the Ufe of 'em in biting would occafion, by preffing upon fuch a Membrane?

## Sect. II. Of the Einamel of the Teeth.

Can any one fuppofe that it is without Wifdom and Defign (fince the naked Bone can rarely endure the Air without Corruption, and the covering it with a Membrane would be here ufelefs and inconvenient) that the Teeth are furrounded with a hard Subftance, which the Author of the Hiffory of the French Academy of Sciences, for the Ycar 169\%, P. 48. calls the Enamel; wherewith they are, as it were, glazed round about, fo far as they are expofed to the open Air; and which as foon as they lofe, they rot and are corrupted. In Tab. I. Fig. I. you may fee a Reprefentation thereof: The Line A C F H is that Part of the Gums out of which the Teeth appear; A E C and FG H are the Roots of the Teeth: The Parts A DCB and FLHII fhew the Enamel or Glazing, which confifts of fmall Fibres ranning parallel to each other, that joyn fometimes at
the Top, but below are feparated from each other: This Enamel covers the whole Too.h as far as it ftands out of the Gums: M M are the little Holes through which the Nerves pafs into the Root of the Teeth of young People, but are clofed in Old, as in N N ; by which means this Part of the Nerves, which are otherwife in the Teeth, is feparated from the remaining Nerves.

The Bone of a Tooth is remarkably harder than all other Bones, and is therefore thought by fome to be of a petrified Subftance, to the End that it might not become ufelefs by Attrition. And whereas ocher Bunes ceafe growing after a certain Age, the Teeth, or at leaft their Enamel, increafes even to old Age, in order to make good the continual wearing of cm : this appears, when we lofe a Tooth out of one of the Jaw-bones, that which is oppofite to it in the other, becoming oftentimes longer than thofe which are next to it.

> SECT. III. Of the Lips.

To fay no more of other Ufes of the Teeth, with refpect to the Beanty of the Countenance, and particularly for Speech, which by their means becomes intelligible, eafie and diftinct : Who can confider the Structure of the Lips without Aftonifhment, and their Motion in fuch various Manners? The Opening of them for the Reception of Food; the Clofing of them again to prevent the fame Food, whilft it is chewed, from falling out of the Mouth; the Ufe of 'em in Humane Speech; by thefe the Children fuck their Mother; and thefe, together with the Tongie and Cheeks, are ufeful in chewing the Food, which not being able to temain under the Jaws and Teeth, is by them, at
every turn, brought back again, till it becomes fmall, and fufficiently moiftened by the Spittle.

## Sect. IV. Of the Glands of the Mouth.

Is it not likewife by a wife Contrivance, and not by meer Chance, that there are in the Mouth fo many Glands or Fountains of Spittle? Since if the Food fhould remain dry, it could not be fwallowed down, but with a great deal of Trouble; whereas the Moifture that proceeds from them by innumerable Orifices, is mingled with Food whillt it is chewed; and this Liquor, or Moifture, is brought thither by long Veffels, and diftant Glands, not only to the aforefaid End, but (which is more) to gire an Occafion for the more eafie converting the folid Food, wherewith it is mixed in the Mouth, into a nutritious liquid Subftance in the Stomach. We flall not here mention the Property of Spittle, in caufing many Things to ferment, or other Qualities, which may be found in the Writings of thofe who have enquired into them, becaufe we will not dwell too long upon this Subject.

## $\mathrm{S}_{\mathrm{Ect}}$ V. Of the Tongue.

Before we take our Leave of the Mouth, I cannot forbear obferving fomething more therein, which every one that fees the Effeets of it, muft needs be aftonifhed at; this is the wonderful Structure of the Tongue : And here I would freely ask all the Arrificers in the World, whether any of them coald have invented fuch a Machine, which having neither Bones nor Joynts, can produce fuch an innumerable Variety of Motions; fometimes making itfelf long and thin, at other times fiort and thick; and in a Minute firring C 3 and which it is not fufceptible?

Can any body think that there is neither Underftanding nor Wifdom made ufe of here by Him who has formed fuch a wonderful Body, only by the knitting together of fome Mufcular Fibres, (if we except fome Glands, the Ufe of which is to moiften it, as it becomes dry) and fix it in a Place where all thefe Motions may have their Ufe?
Let the moft obdurate and deplorable Atheif confider with himfelf, whether there is the leaft Shadow or Appearance of Truth for his afcribing this to meer Chance, or to natural Laws working neceflarily, and without any wife Determination.

This Tongue lies in the Mouth, where the Sound that comes out of the Wind-pipe paffes thro'; and which, by the Motion of the Tongue; becomes diftinct; and fo forming all Speeches and Languages, produces this great Wonder, that a Man, by the Motion of fuch an Inftrument, can communicate the Thoughts of his Soul to another; whereas, if it were otherwife placed, or if it were not of fuch a Texture and Property, the whole World would be brought into Confufion: This may be obferv'd in thofe, who by Deafnefs or other Accidents have the Misfortune of not being able to ufe their Tongue: How great is the Trouble and Difficulty they find in expreffing their Thoughts to other Men ? In fhort, every one may eafily reprefent to himfelf what a Diforder it would be, fuppofing all Men dumb, if we were obliged to make ufe of other Signs and Tokens, in order to carry on any Commerce or other Bufisefs with one another; not to mention the Prejadice which the teaching of all

Sciences,

Sciences, and in a manner every thing that paffes among Men, would fuffer thereby.

The Tongue does alfo lie upon that Place, thro' which the Meat and Drink paffes ; and befides its other Faculties, is a principal Inftrument of Tatte. If it had not this Property, how many People would eat without any Pleafure or Satiffaction? Nay, fo neceffary a Work would be very tedious and irkfome to many.
Can any one again perfwade himfelf that he is not beholden to the Wifdom and Goodnefs of his Creator, who has placed this Tongue in the Mouth, and endow'd it with all thefe Propercies? Could any Man ever fhow in the very beft Machine of Humane Invention, fo many Wonders in the Structure thereof, fo much Wifdom in the Difpofition of the Parts, fo many Advantages in the Ufe of it ? And can all difcover the Hand of a wife Artificer in the Formation of a much meaner Inftrument? How miferably blind are fuch Men, who cannot fee in this wonderful and amazing Structure of the Tongue, a Wife, Powerful and Gracious Creator, and fill prefume to affirm that all this comes to pafs by Chance, at leaft without Knowledge?

Not to mention here exprefly that Service and Ufe of the Tongue which preferves all Men alive, viz. by thrufting the Food, after it has been chewed in the Mouth, down the Throat; without which we fhould not be able to fwallow at all, or at leaft but with great Difficulty ; the Inconveniencies of which, all fuch as have loft this Faculty by Swellings in thofe Parts, are very fenfible of.

[^1]
## S£ct. VI. Of the Throat.

No w, if we pals on to the Throat, whither the Food leads us from the Mouth and Tongue; and if we confider the Structure thereof, can any one imagine that it was fo contrived without any Wifdom, that the Orifice, or Opening of the Throat, is dilated by three Pair of different Mufcles, (fee Tab. I. Fig. 2. B B, C C, D D,) like a Bag by fix Hands, to the End that the-Food; which the Tongue drives thitherwards, may be fwallowed, and defcend without any Trouble: being drawn up fo much higher backwards, by the Mufcles D D, that the Food paffing over the lower Brim thereof, and ftriking againft the hinder Part, fhould not fail to find the right Entrance of the Throat, which being compofed of a moift Membrane, would clofe together, or at leaft hinder the fwallowing, if thofe Mufcles were not placed there.

## SECT. VII. Of the Wind-pipe.

But herein appears yet more fenfibly the Defign and Wifdom of the Great Artificer, in ordering the Food to pals over the Orifice of the Wind-pipe as it goes to the Throat: For if any thing falls into the Wind-pipe (which People commonly call going the wrong Way) every one knows, what Diforder it occafions in them, fa great fometimes as to pur them in danger of choaking; wherefore it is abfolutely neceflary, if we soould eat with Eafe, and preferve our Life at the fame time, that the Wind-pipe, or the Mouth of it, fhould be clofed when we fwallow, and then immediately open'd again in order to draw our Breath : Now can any body be fo dull
as not to obferve this determinate End and Defign of our Wife and Merciful Creator! Let him only take the Trouble of viewing the upper Part of the Wind-pipe of a Sheep or a Calf, where he will fee more plainly than can be flewn him here by a Figure, that there lies a Cartilage, called the Epiglotti, which being preffed down by the Food, when 'tis fwallowed, covers the Orifice of the Wind-pipe lying under it, by which means the Food paffing over it, as if it were a Bridge made for that Purpofe, in its Way to the Throat, is prevented from falling into the Wind-pipe, which would often occafion coughing, fraining, and other greater Inconveniencies.

Now if this Cartilage fhould remain lying thus upon the Orifice of the Wind-pipe, the Breath would be ftopt, and the living Creature immediately fuffocated. Do we not here again difcover a wife Defign, that this Epiglotti is fo contriv'd, as to rife up like a Spring that has been preffed down, or as fome fay, drawn up by Mufcular Fibres after the Food has paffed over it? By which means the Paffage of the Breath is immediately open'd after fwallowing, in cafe the Elaftical Force of the faid Epiglotti fhould be weaken'd by too much Ufe.

SEC T. VIII. Convictions from what has been faid above.
Now let a Man confider all thefe things together, as they appear in fo fmall a Place as the Cavity of the Mouth, and fee whether he call ftill fuppofe that all of them, fo manifold in Number, fo neceffary to our Life and Wellbeing, could have met together in fuch a narrow Circumference, without any Defign of the Maker, and by meer Chance or ignorant Caufes? Can he not clearly difcover therein a Wifdom, Power and Goodnefs,

Goodnefs, which contrived all this, in order to fupport this Part of the Humane Body, and to preferve it from fudden Death by Suffocation or Strangling ? And let any one fay, if he can, that in a Place not above a Span long, where fo many Difpofitions of fo many different things, for the attaining fuch weighty Purpofes do appear ; that all this is brought about, by Caufes ignorant of their own Work.

> S ECT. IX. About Sucking, and of Places from which the Air is exbaufted.

Before we conclude this Difcourfe, I mult add fomething, which as often as I confider it, does every time excite in me a new Aftonifhment.

All the Learned World knows the juft Praifes that have been given to the famous Terricelli, Gueric, Boyle, and others, who were the firf Inventers of the Art of producing a Vacuum, or Place void of Air, by the fubfiding or finking of Quick-filver, or otherwife by Air-Pumps, whereby fo many Secrets of Nature have been difcover'd. And can we fee without fanding amazed at the All-comprehending Wifdom of our Great Creator, who has prepared and fitted the Mouth of all Men for an Inftrument to produce the fame Effect! The Action which is called Sucking, is a plain Demonitration thersof, and is performed by putting the Tongue and Lips together, or otherwife, only by leaving a little Cavity between them firft open, and afterwards drawing the Tongue backwards, which makes a Hollownefs that was not there before between the Tongue and Lips, and confequently empties it of Air; or otherwife, by drawing the Tongue back, makes the Cavity that was there larger, giving the Air that was in the Place more room,
and fo leffens the Preflure and Refiftance of it in that Place ; by which means the Liquor (into which one End of a Pipe is put, and the other into the Cavity of the Mouth, which has been emptied of its Air) being preffed by the External Air, and finding in the Month little or no Refiftance, is forced up thither. The fame Effeet is feen in the Sucking up of Smoak by thofe that take Tobacco.

## SE CT. X. Sucking, as performed by Cbildren.

Bur that which ought to be not only furprifing, but aftonifhing to every body, is, that this fo artful a manner of producing a Vouium is performed by Children newly born, and even by all the moft irrational Creatures, which, by Sucking their Dams as foon as they come into the World, are already taught to begin to fupport their own Lives. Can thefe know that the Air has an expanfive Faculty? That it preffes all things with fo great a Weight? That to cayfe the Milk to come out of the Breaft with fuch a Preflure, there mult be a Vacuum, or Place void of Air, made before the Orifices of the Nipples? That this Place mult be fo clofed on all Sides, that tho' the Air, in order to Refpiration, paffing thro' the Noftrils, can infinuate itfelf by the fmalleft Opening, yet it mult be prevented from coming into this Vacuum; for in fuch a cafe the Sucking, or the flowing of the Milk, would ceafe; all which things muft be well obferv'd by fuch as make Inftruments proper for Sucking, as they are exactly followed by Nature; which teaches ignorant Children, and even brute Beafts, to form this curious Machine, and to ufe it according to the fricteft Rules of Art. vations.

Now let the unhappy Patrons of the defperate Sentiments of an Epicurus and Lucretius feriounly confider thefe things with us, and fee whether their Fundamental Principle can obtain here, viz. that all things are produced without a certain End or Defign of the Creator, and that Men only finding 'em fo prepared to their hands, do make their Ufe of them. Is it to be believed that this can happen with Children, and all other Creatures, as foon as they are born, which do not fo much as know that there is fuch a thing as Air, much lefs how to apply it to this Purpofe? Can any Man, endow'd with Reafon, think that the dulleft and moft ignorant of all living Creatures are immediately capable to apply fuch a Machine to its right Ufe? Whereas Men of the greateft Learning iand Underfanding will readily own how difficult it is at firft for them to underftand and ufe the fame rightly; every one can witnefs this the firft time he takes an Air-pump into his hand.

And to give a convincing Proof that the Inftruments made ufe of for Children and young Creatures in Sucking, are produced by infinite Wifdom for that Purpofe, we need only enquire into the wonderful Structure of the Mufcles of the Lips and Tongue, and the flefly Fibres of which they are compofed, and which are fo well defcrib'd by all skilful Anatomifts. If we would allow Reafon to take place, we fhould be fufficiently fatisfied by this fingle Inftance; that, becaufe that Paffage is fopt in Sucking, which upon other occafions is prepared for the Air, the adorable Creator, and
great Preferver of all things living, has fo difpofed the Noftrils, that they may ferve for breathing during the Action of Sucking; and fo this great Work, fo neceflary to new-born Creatures, might not be obftructed at every turn. A Proof of this is feen in Nurfes, who, when they have a mind that the Child fhould leave off Sucking, fop theirNofe with their Finger, by which means their breathing that way being hindred, they immediately quit the Breaf, that they may draw in the Air by their Mouths.

How defperately blind muit he be, who in all this does not obferve the Wifdom of his Creator! that has after fo wonderful a manner contriv'd this fo great and fo neceffary a Work, whereby all living Creatures are, as foon as born, preferv'd from perifhing for lack of Food, even then when the Nature of SuEtion was unknown to Mankind? For it is plain, beyond all need of Proof, that none of the old Philofophers (as far as appears by their Writings) knew any thing of the matter, till that in the laft Century the Properties of the Air were difcovered.

Since it is not conceivable how any one can have a juft Notion of the Nature of Suction, without owning at the fame time the amazing Wifdom of him who (to fay nothing of Womens Breafts) has adapted the Mouths of Children to perform a Work of fo much Art; could any Man likewife behold a Machine form'd for making a Vacuum, or for exhaufting Air, not compofed of any folid Matter, fuch as Brafs, Iron or Glafs, (of which Air-pumps and Barometers are ufually made) but only of flabby Membranes, and flexible Fibres joyn'd together, fuch as the Mufcles are made of; I fay, could any one fee thefe Wonders perform'd by fuch Inftruments,
and imagine them to be form'd without any Skill in Mechanicks, by meer Chance, at leaft without Wifdom or Defign ?

Let the moft obdurate Atheift, even tho' he were a great Mathematician, fet about a Work, of the like Nature, and try whether with all the Skill he is Mafter of, he can produce fo compleat a Machine out of fuch unapt Matter; and if he could frame one, even after a much more imperfeet manner, would he not think that fuch an Invention ought to procure him the Praifes of the greateft Mechanifts? And can he then think himfelf Juft or Reafonable, to refufe thofe Praifes to that Glorious Creator, who has placed and fixed fuch a Machine in the Mouths of all Men, and of many other Animals!


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## Contemplation IV.

## Of the Throat, Stomach, and Bowels.

## $\mathrm{S}_{\mathrm{EC}} \mathrm{T}$. I. Concerning the Throat.

LET us now go on, and contemplate the Structure and Function of the Throat, as it extends irfelf from the Mouth to the Stomach.

The Food being fufficiently chewed in the Mouth, and being conveyed in the manner as has been before defribed, into the Throat, thro' the Orifice or Opening thereof, (Tab.1. Fig. 2. E) if it were to defcend by its Weight only, it would require a great deal of Time to pars into the Stomach thro' this Tube, becaufe of its being membranous and moift, 个o that the Parts of it would flick together ; efpecially, if any Piece of Food, by its Largenefs and Solidity, fhould extend the Throat in its Defcent, and thereby contract thofe Parts that are above and below the faid Food: To fay nothing of the Throat of Beafts, which lies horizontally, or even afcends when they feed upon the Ground; in fuch a cafe, I fay, that which is fwallowed would not be able to proceed into the Stomach.

Now, to prevent all thefe Inconveniencies, it has pleafed the Gracious Creator to place there a Murcle, A A, (which is here reprefented, cut thro', and is by fome taken for two) the Fibres of which encompaffing the Throat, and contrating themfelves, do thereby fqueeze it, and fof force the Food to defcend; for whaterer the Caufe be, it is

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experimentally true, that all the Mufcles of the Body operate, by contracting or fhortning their Fibres.

Secr. II. The Strait and Circular Fibres of the Throat.

Can we further confider the wonderful Order in which this Tube is framed, without acknowledging a Wifdom therein that intended the Protrufion of the Food into the Stomach! Since the outward Membrane E being taken off and laid afide at $a$ (which is to be underfood in all thofe Places where you meet with the Letter $a$ in this Figure) the Mufcular Fibres F fhew themfelves, defcending perpendicularly, or lengthwife, according to the whole Extenfion of the Throat ; having others under them, as in $G$, which encompafs the Throat like Rings or Circles: Let us now imagine, that thefe two Sorts of Fibres, viz. thofe that run lengthwife at F, and the Circular at G, were contracted; we fhould then perceive that thefe laft Circular Fibres, fhortening themfelves behind and above the Part where the Food lies, protrude the fame downwards, after the fame manner as the Women that make Saufages are wont to do, by fqueezing the Matter with their Hand, in order to make the fame go forward into the Bag or Gut that is to contain it ; whilft in the mean time, the long Fibres, by fhortening themfelves likewife, do widen the Place thro' which the Food is to pals, to the End it may be the more eafily thruft down by the Contraction of the Circular Fibres.

Now that this Motion and Progreffion of the Food towards the Stomach is perform'd by fuch a kind of Force, and not by its own Weight, is plain by Childrens fwallowing their Vi\&tuals into
the Stomach upwards when they ftand upon their Heads: Upon which Account every one of us is moft highly obliged to the Goodnefs of our Creator; becaufe otherwife no body could take in any Food in the Pofture of lying down; which how exceeding, inconvenient it would be to fick and diftemper'd People, is not neceflary to be farther defcribed.

SECT. III. Of other Tunicles or Coats of the Throat.

O NE thing further feemed requifite towards rendering the Paffage of the Food yet more eafy, viz. That the Tube above-mention'd, for the better performing its Function, fhould be kept conftantly moift ; forafmuch as the Food being fometimes dry, its Motion and Defcent would be perform'd more flowly and with greater Trouble.

Can we therefore difcover no Wifdom herein; that in order to produce fuch an Effect, the faid Throat has a Tunicle full of Blood-Veffels, that is of Veins and Arteries, (See Tab I. Fig. 2. H.) and yet another under that at I, which is called the Glandulous Tunick, -becaufe it is full of little Gands, from whence a Liquor is feparated from the Arteries, which renders the under-lying K , called the Nervous Coat, fmooth and lippery, that it may be fit for the faid Ufes? It ought likewife to be obferved here, that thefe Glands in this Coat or Tunicle are placed exactly between flefhy Fibres for this Reafon, that thereby they may be more or lefs preffed, in order to difcharge their Moifture according as there is occafion; for which Caufe likewife, this laft Tunicle is endued with a foft Woolinefs on the Infide, which in fome meafure is able to fop ar

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hinder the Moifture from paffing away till it has perfomed its Function of making the Parts nippery; when there is too little of this Moifture, and the Throat is too dry, that which we call Thirft, feems to be produced, which is a natural Warning that Moifure is there wanted.

SECT.IV. Convictions from the foregoing Obfervations.
Now can any one imagine, that all thiswonderful Structure of the Parts of the Throat is produced by Chance, without any View or Refpect to the Order and Ufes for which they are defigned! which befides thofe artful Inftruments for forcing the Food to defcend into the Stomach, befides the Veins that feed it, and by the Moifture which is feparated in the Glands, contribute to make it fmooth, has likewife in itfelf the Property of warning us when we ought to moiften it, at fuch Times as its own natural Juices are not fufficient to perform the fame, by reafon of the Drynefs of the Food, or other Accidents : And if any Body does perfift in affirming that all this is owing to Chance, why fhould he be afhamed to fay, that a Spout or Pipe, by which the Rainwater is conveyed from the Top of a Houfe into a Ciftern (which in comparifon of the Structure of the Throat, has nothing of Skill in it) was produced in that Place by a meer Accident, and without any End or Defign?

## S e ct. V. Of the Stomach.

Now in care the Stomach DCDT, (Tab.I. Fig. 3.) were as narrow as the Throat E A, or as the Inteftines GHHII, both which make one and the fame continued Tube with the Stomach, and that the Food fhould pars thro' all of them
with equal Force and Swiftnefs, it would not be poffible that the fame fhould be rightly prepared or, as they call it, macerated and converted from a folid Body into a fluid Matter proper for Nourifoment.

And here again do we not fee plain Footfteps of a wife End in contriving the Stomach to be fo much larger and hollower, in order to contain at once all the Meat and Drink that is fent down into it? and befides of fuch a Structure, as not to fuftier the fame to pafs too foon thro' it, as it happens in all the other Parts of this great and long Tube ?

Thus we fee that the Food defcending from E A into the Stomach B , is hinder'd from proceeding further, by Reafon that the extreme Part or End of the Stomach C, by which the Food is to be difcharged, is fo much higher than the Belly of it in which it lies; whereby it is obliged to remain there for a while, in order to be turned into a fort of Pap, which the Anatomifts call Chylus or Chymus ; or as fome will have it, till the Quin= tefcence thereof be extracted.

And what I carnot pals over here without a Note of Admiration is, That according to the Obfervations of that great Anatomift Verheyen, the difcharging Part C is not raifed up to that heighth, but juft at the Time when the Stomach is full and extended, and fo is capable of hindering the Food from paffing too fwiftly thro ${ }^{3}$ it; whereas otherwife when the Stomach is empty, it finks down much lower. Can any one fee this without difcovering the Defign of the Great Creator, to con $=$ tinue the Food a fufficient Time in the Stomach !

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D_{2} \quad \text { SECT: }
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$S_{\text {EC T }}$. VI. The Fuices of the Stomach, and concerning the Mufcular Valve.

Now whether the Confumption of the Food happetis after one or the other Manner, it was neceffary in both Cafes, that there fhould be more Moifture mixed with it in the Stomach, in order to put it into a Fermentation, or otherwife to convert into that fluid Matter called Chyle.

Can it now be thought, that meer Chance produced fuch a valt Number of Arteries in the Stomach as you may fee at D D, $d d$; and fuch a wonderful Number likewife of Nerves, fpreading like fo many Branches out of Eand F, which convey into it fuch a Moifture and Nervous Juice by the Glands that are placed on purpofe, that together with the Spittle which is mixed with the Food in Chewing, they may make a new Liquor proper for the Attrition or Breaking of the Food; and to the End that it may remain long enough therein, the extreme Part of the Stomach B (Tab.I. Fig. 4.) is fhut up with a Mufcle that encompaffes and contracts the fame, and which therefore cannot be opened but with a greater Force or Preffure?

> S ect. VII. The Fibres of the Stomach.
$T_{\text {he }}$ Food having remained fome Hours in the Stomach, in order to its Change, muft afterwards purfue its way for the Nourifhment of the whole Body: Can any one then think that it hapn, ns. without the efpecial Wifdom of God, that every Thing is found in the Stomach adapted in the beft manner to promote this Purpofe?

1. By
2. By the infenfibly oblique Afcenfion from the Bottom of the Stomach to the Paffage C (Tab. I. Fig. 3.) in order to difcharge the fame: Whereas if this laft Orifice was of the fame Structure as that at A, thro' which the Food paffes into the Stomach, it is plain that the Difcharge thereof could not be performed but with very great Trouble.
3. Add to this, that the external Fibres of the Stomach are extended lengthwife in it, and being florten'd in their Operation, they likewife render the Stomach fo much fhorter ; and in order to exert themfelves with greater Strength at both the Orifices A and C, as alfo at the Bottom of the Stomach, they become mufculous.
4. Moreover (Tab. I. Fig. 4.) other ftronger Fibres D encompals the Stomach annularly, and crofs the former, which being drawn together, make the Stomach narrower.
5. Under thefe there lie yet another Row of Fibres (Tab. I. Fig. 5.) which run obliquely A, extending themfelves from the uppermof Part of the Stomach to the Bottom thereof, drawing obliquely the End $\mathbf{M}$ towards the Beginning N.

Now let any one fuppofe, that he held this Stomach CT full of a fluid Matter in his Hand, and that it was to continue in the fame Pofition in relation to the Heighth of its lower End C: Could he poffibly invent a better Way to difcharge the faid Matter by the Orifice C, as firf by clofing the Orifice A, and afterwards contracting the Stomach, by pinching it togerher lengthwife from C to A ; by which means the inclofed Matter being thruft againft the Left end of the Stomach T , muft neceffarily be forced out at the Right end where the Orifice C is ?

Now how particulariy ferviceable the frong Mufcular Fibres B (Tab. I. Fig. 5.) are thereto, is plain, firf, becaufe they encompaffing the Left Orifice of the Stomach I, do fhut the fame exactly at the Time when the Food is thruft out at the other Orifice K, to the End that the Chyle may not be driven back again into the Throat thro' the Orifice IP. Secondly, Becaufe thefe Fibres B running lengthwife, are inferted in the right Paflige of the Stomach K, which when they become fhorter, they draw towards themfeives, and by this one Action do at the fame time contract or fhorten the Stomach from Mito N, and whilft they fhut one Orifice I, they do in fome manner dilate the other $\mathbf{K}$; infomuch that it is impoffible, when all there Fibres are contrated and perform their Function, but that the Chyle fliould be protruded by the Orifice K K.

How comes it to pafs now, if all this be done by Chance, that thefe Fibres of the Stomach run, of are extended fo differently from thofe of the Throat, and thofe of the Bowels, which fhall be accounted for hereafter? And whence comes it, that each of them is adapted, in the mof proper manner, to its right Ufe, and the Fundtions that are required of it? Can the wonderful Structure of the Fibres be deemed accidental! Why don't they fay the fame of the Preparation of the Ropes that are ufed in the drawing up of a * Rammer, in which, comparatively, there is very little Art?

[^2]Sect. VIII. The Mucilage or Slime of the Stomach.
Besides all this, there is often a Neceffity in fome Perfons, for an Acid Matter to compleat the Diffolution of fome kinds of Food; of which Nature are alfo feveral Medicines, fuch as Vinegar, Verjuice, Lemon-Liquor, Muftard, Pepper-Root, and almoft all Spices, all Salts, as well the Common as Volatile, and others, which are all Acid, and neverthelefs very neceffary on fome occafions. Now, forafmuch as the Stomach is membranous, and the Membranes thereof extreamly fenfible, there was danger, that by fuch fharp Matters it might either be affected with Pain, or elfe irritated to Vomiting or other irregular Motions. Can we therefore here, without Thankfulnefs and Afonifhment too, obferve, how it has pleafed our Gracious Creator, with great Wifdom to provide againft the fame, by cloathing the innermoft Part of the Stomach and Bowels with a thick and tough Slime, (whereby they are defended from the Corrofion of thofe flharp Matters) which is ftopt there, and adheres to fmall Fibres, that ftand ftreight up on the fides of the Stomach, like the Silk Thread in Velvet, to prevent the faid Slime from being carried away immediately by the Food that paffes thro' the Stomach!

Can any body now, confidering what has been here faid about the Stomach, (tho' for Brevity fake I have defignedly omitted feveral remarkable Circumfances) remain unconvinced that it was a Great Creator who, in order to difplay his Wifdom and Goodnefs to Mankind, has produced all this in fuch a beautiful Order! And can he, without Scruple, afcribe this whole Structure to ignorant Caufes! the rather, becaufe any one of thefe Circumftances failing, very difmal Confe-

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$$ tumes follow.

Sect.IX Of Hunger.

To fay nothing more about the Stomach, which feems plainly to prove the Defign of Him that made it; are we not particularly obliged to return him our Thanks for having been pleafed, over and above, to add to the Structure of the Stomach, befides fo many other neceffary Ufes, the following Property, viz. Hunger; by feeling which, we are acquainted, that we ftand in need of new Food and Refrefhment, of which, without fuch a Warning, we flould not be fenfible oftentimes, till we become weak and faint, and unfit for Bufinefs for want of the fame.

He muft be miferably blind who cannot difcover a Wife and Gracious Maker of all thefe things; or that can perfwade himfelf, that their skilful Structure, and fo many Conveniencies and regular and well adapted Ufes, can be produced by meer Chance or irrational Caufes.

## Sect. X. The Ufes of the Guts.

Let us now pals on with the Food to the Bowels or Guts; to know the Conftruction of which, you may confider the Tube (Tab. I. Fig. 2.) reprefenting the Gullet and the Stomach as Parts of the Bowels to which they are annex'd, fince the Membranes and Tunicks thereof are for the moft part analogous with thofe of the Guts, and fo are its Motionstoo, bywhich the Matter contain'd therein is protruded; for which reafon we fhall not repeat the fame here.

This Tube has the following great Ufes; (Fig.r.) Firft, that it feparates that which is proper for Nourifhment from the unneceffary Parts, convey-
ing
ing it to the Vena Lactea, or Milky Veins; Secondly, that it carries the Remainder of the Food to the Inteftinum Rectum, in order to be there difcharged.

Now to fpeak of this laft in the firft place, it will not be neceffary to fay, after the Defcription of the Gullet and Stomach, that this is alfo performed by the long and circular Fibres, which do likewife both here produce, by contracting and fhorrning themfelves, a protrufive Motion, called by the Anatomifts, The Periffaltic Motion.
SECT. X. The Mefentery.

You may fee how thefe Bowels are placed in the Body, in Tab. I. Fig. 3. Now in cafe this Tube of the Bowels was fhort, there would be danger that the Chyle, or nourifhing Juice, extracted from the Food, might in a great meafure be difcharged with the ufelefs Part thereof. Is it therefore without a Defign of the Maker that there are fo many Meanders or Windings therein; fo that it is very near fix times the Length of a Man? And particularly, that notwithftanding all its Turnings, it is faften'd in fuch a manner to the Mefentery, that it is not poffible for the Food either to miftake its way, by reafon of the length of the Inteftines, or to take any fuch turn, as that the way thro' which the Chyle paffes fhould be ftopt; as may be feen in Tab.I. Fig. 6. where $G G$ reprefents the Mefentery, and L L the Bowels or Guts faften'd to it, but both extended.

Now can any one fee without Aftonifhment, that in this Membrane (which being only flat and round, would be too big to lie conveniently in the Belly, in cafe it fhould be faften'd to fuch a great Length of the Bowels in its Circumference) fuch a wonderful Method is ufed by our moft wife Creator for that purpofe, viz. by plaiting it upwards and downwards upon the Edge of the Mefentery, the Inteftines defcribed by P Q, R S, (Tab. I. Fig. 6.) and more fully in the 2 Fig. of the 18 Tab . of Verheyen, in the ruffled Edge BB of this expanded Mefentery; to which, that we may not multiply the Figures too much, we refer thofe that are defirous to fee it in its true State. It is by this means, that tho the fame is not above two Spans breadth in a Man of a middle Size, yet by thefe Plaits and Folds it acquires fo much Length, as to afford fufficient room for the Tube of the Inteftines, which is fo much longer, to be faften'd to it. Now in cafe this Problem had been laid before a great and able Mathematician, would not he have thought that he had acquired no fmall Honour, by folving it after this manner? And can any body fancy that this is performed by Chance, or without Wifdom!

## SECT. XII. The Glands of the Intefines.

No w whilft the nutricious Juices are continu:ally feparated from the Food in the Bowels, and by Openings, which are found in their Membranes pafs into the external Parts, as we fhall fhew hereafter; it feems as if it could not be avoided, that the Remainder being thereby become dryer, fhould be hinder'd from proceeding conveniently on its way in this Tube. To remove this Difficulty, the adorable Creator has been pleafed to place feveral Glands in the Inteftines, from whence they filtrate a Liquor fufficient to foften the Excrements, befides others proceeding out of the Glandulous Coat of the Bowels themfelves, which help to render the Paffage fmooth and flippery, and fo fit for the intended Service.


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Can this likewife be faid to be done by Chance! Why then are thefe Glands fmaller and fewer in the thin Guts G, H H, I I, (Tab.I. Fig. 3.) which lie next to the Stomach, where that which is in it has a great deal of Chyle and Moifture? And why are thofe Glands multiplied about the End of thefe thin Guts, unlefs it were that the ufelefs Matter, being by the Separation of the Chyle grown dryer, wants more Moifture to render it fo fluid; and to the end that what fill remain'd in it of the Chyle may be fqueezed out of it ; after the manner of the Apothecaries, who, in order to extract the Juices from their Drugs when they are pretty dry, put fome Liquor in while they are pounding them? Laftly, why are thofe Glands in the thick Guts $\mathrm{M}, \mathrm{N}$ N N , O, that lie fartheft from the Stomach, and where the Matter to be difcharged is in a manner divefted of all its Chylous Juice, the biggeft of all; unlefs it be, that the greateft Moifture is there requifite to prevent its being too hard ?

SEct. XIII. The Wrinkles, Valves, and Inteftinum Rectum.

Now not to mention the Wrinkles of the thins Guts, the Ufe of which is to hinder the digefted Food, that has fill fome Chyle in it, from paffing too fwiftly thro' thofe Orifices that are made to receive the Chyle, nor the great Valve K , at the end of thofe thin Guts, whercby the Matter that is hardly now of any further Ufe, is hindred from going back: Why are the thick Inteftines larger, and furnifhed with fo many feparated Places, unlefs it be to collect the ufelefs Matter therein, and to the end that People may not be too frequently obliged to difcharge the fame?

Is it not therefore very plain, that the Inteffinum ReCtum OP, is only contrived for difcharging the abovefaid Matter? Why does it defcend Atreight forwards, unlefs it were, that the Difcharge of the faid Matter fhould not be obftructed by unneceffary Windings and Turnings?

Is all this made without fuch a Defign! Why is there a round contracting Mufcle $P$, which, like a Ring, pinches this Bowel at the end of it? Is it not to hinder an inceffant Protrufion of the Excrementitious Palts, by the continual Periftaltic Motion of the Inteltines? And fince that in feveral Difcharges, when the Matter is hard, the Intefinum Rectum O P, is preffed and finks downwards, we may fee that the two Mufcles QP and $Q P$, are placed there on purpofe to fecure it; for by their Affiftahce, the fhutring Mufcle and the Inteftinum ReCZum are drawn back again, after a difficult Difcharge, and made to afcend by the fhortning of their Fibres.

Sect. XIV. The Ufes of the Oblique and Lateral Mufcles of the Belly.

AND forafmuch as the Protrufive Motion of the Bowes is not fometimes ftrong enough alone to difcharge the Excrementitious Matter, ought we not likewife herein to adore the exceeding great Wifdom of the Creator, who, befides the Diaphragma or Midriff, has after fo wonderful a manner made the whole Covering, or Tegument of the Belly, to be affifing thereto; by which means the expulive Force may be render'd incomparably greater, as often as there is any occafion for it?

In order thereto, People are wont, firf, ftrongly to draw in their Breath; by doing of which the Midriff lying juft above the Stomach, fo violently p.effes
preffes upon all the Bowels, fo that unlefs they oppofe it on purpofe, the whole Beliy rifeth therewith, to the end that the Guts may be preffed more clofely together.

Now fince the Bowels, thus prefs'd down by the Midriff, are forced to dilate themfelves outwardly in the Belly, unlefs the extended Covering of the Belly did again contract itfelf by the Action of its Mufcles, and prefs the Bowels together with a ftrong Force, the Excrements cou'd not be protruded thro' the Inteftinum Rectum: But fince that Inteltine is open, and at the fame time the Bowels are prefs'd together from all Parts, the Matter contain'd in them muft beprotruded thro' the Orifice of the faid Rectum.

Now, how wonderfully this comprehenfive Force is produced by the Mufcles which compofe the Coverings of the Belly, is plain to thofe that are acquainted with the Structure thereof.

To give you fome Notion of it here, without mentioning the ufual Coverings which the Belly has in coinmon with many other Parts; (Tab. II. Fig. 1.) A is the Cuticula or upper Skin, B the Cutis or Skin, C the Fat, D the flefly Tegument or Covering ; the external Parts thereof to confift, on both fides, firft, of the Mufcle G, the Fibres of which defcend obliquely from the Vertebra of the Loyns to the Linea Alba K K, which runs downwards from the Breaft-bone thro' the Navel L to the Os Pubis, and is of a ftrong and fibrous Structure, in order to refift the Force of the Mufcles drawing againft one another on each fide: The Mufcle of the fame Name and Kind belonging to the other fide, is laid open at O , in order to fhew that which is under it. Secondly, we fee another pair of Mufcles lying under the former, the Fibres of which running up wards obliquely from the Vertebra to the aforefaid Linea Alba.

KK, do crofs thofe of the firft Mufcle ; as appears here ar M , on the one fide, under a part of the firft Mufcle, which is turned up ; and on the other fide at $P$, where it is fully feparated. Thirdly, There are a pair of Mufcles that lie underneath the fame, on the right fide at $U$, the Fibres of which are extended laterally or crofs, and not obliquely, from the Vertebra to the Linea Alba, ot White Line K K: The tranfverfe Mufcle of the left Side is not vifible in this Figure, becaule of the Mufcles that lie upon it, called the Lateral.

Let us now fuppofe that thefe two loweft lateral Mufcles V, do encompafs the Belly quite round, and in that manner compofe a Cavity, which contains the Bowels; and further, that all the Fibres of which they are made up, are fhorten'd or contracted: It is plain, that the Cavity has thereby a leffer Circumference, and confequently muft be narrower; and fo the Bowels therein contain'd will be prefied together on all fides.

But fince thofe Mufcles are not only ferviceable in the Evacuation of the Bowels, but likewife of the Bladder, and even in the Labour of Child-bearing Women, to whom they are of the greateft Ufe in that important Cafe , it was neceffary that this Preflure fhould be performed with very great Force; for which Reafon the wife Creator has placed another pair of Mufcles (one of which is reprefented by M) upon the Lateral, the Fibres of which running obliquely upwards, as is faid before, and ending in the Linea Alba K K, when they operate and become fhorter, do in like manner contract the Belly; but they do alfo at the fame time (as' is well known to the Mathematicians) by their Obliquity extended upwards, as it were draw down the whole Linea Alba K K. Now to obviate the Inconveniencies that might proceed from hence, the Fibres of the Mufcles $G$, that lie upon thele, do run with a quite contrary Obliquity downwards; whereby the Belly is not only contracted with a new Force, but the Linera Alba K K, is again drawn upwards by this contrary Obliquity.

Sect. XV. The Ufe of the Pyramidal Mufcles.
Now if each Pair of thefe laft oblique Mufcles operated with like Force upon the Likea Alba, and that the fame was drawn as much upwards by one Pair as downwards by the other, they would balance one another ; and this White Line K K, would remain in its Place, without moving one way or the other: But fince thefe laft and uppermoft defcending Mufcles $G$, are much larger and ftronger than thofe that lie under at M , it mult follow, that whilft they operate together to difcharge the Belly, by this over-balance of Force, thefe Fibres or White Lines K K, will be conftantly drawn fomething upwards.

Can it now be brought about by Chance, that we meet with a Pair of Mufcles $S$ and $T$, under the Os pubis (the laft of which $\mathbf{T}$, is fhewn feparated, and hanging downwards out of its Place) which, from the Figure of them, are called Pyramidal, and whereof the Fibres do only run upwards along the White Lines to K , or about as high as the Navel ; fo that it is very plainto every Body, that being fhorter at $S$, and confequently their Fibres being drawn downwards, the Linea Alba, to which the Fibres are faften'd, muft likewife follow downwards; and therefore thefe Pyramidal Mufcles feem to be made ufe of as a Balance of the Force, by which the defcending oblique Mufcles at $G$, do exceed the afcending oblique ones at M ; and whereby, if not prevented by the Pyramidal, the White Lines would otherwife forafmuch as in many Bodies there are found but one of thefe Pyramidal Murcles, and not alway: juft two ; fince one that is big enough can anfwet the aforefaid Ufes : Nor yet are the fame neceffa: ry, when the afcending and defcending obliqus Mufcles are of equal Strength, as has been fometimes obferved.

## Sect. XVI. The UJe of the Right Mufles.

But befides all this, there feems fill to remain the following Inconveniency; that the Belly being contracted by thefe Mufcles with fo great Force only fideways, the Inteftines -would hereby be preffed as much upwards as downwards, and would tikewife be driven with too great Violence upwards againft the Midriff; $f 0$ that the flexible Struture of the Cartilages would be raifed upwards, by which Means the Protrufive Faculty would be weaken'd. To prevent which, and that nothing fhould be deficient in this great Work, the Wirdom of the Sovereign Creator feems to have faften'd two other Murcles QQQ called the Right, to the Os Pubis at S, after fuch a manner, that their other Extremities Y Y, fhould be faftened to and about the Breaft-bone; whereby thefe being contraated, or made fhorter in their Fibres, draw the Ribs, with their Cartilages (which terminate in the Brealt-bone) downwards; and fo they do not only hold faft to the Places to which the Midriff is fixt, but likewife hinder the fame from bending upwards by the ffrong Preffure of the Bowels againft the Midriff, when thofe Bowels are thruft upwards and downswards: by the aforefaid annular Murcles of the Belly.

There are likewife feen in the Right Mufcles QQQ, three or four Lateral white Fibres R R R;
which

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which do moft commonly divide each Right Mufcle into four other, following one another, to the End, that thefe Mufcles may perform their Function by a leffer Contraction, and proportionably by a leffer Tumifaction, and fo not take up too much room; which otherwife, in cafe the Flefhly Fibres of the Os Pubis fhould extend themfelves to the Breaft-bone, would not be perform'd fo regularly or conveniently.

The other Ufes which are afcribed by the Anatomits to thefe Right and Pyramidal Mufcles, may be feen and confider'd by every one in their Writings; we having dwelt long enough upon them here already.

SEct. XVII. Orifices in the Mufcles for the Seminal Veffels.
$\mathrm{H}_{\mathrm{E}}$ that is not fatisfied, that all thefe things are performed for wife Purpofes, let him caft his Eyes farther in Tab. II. Fig. I. upon the Orifices defcribed by the Letter I, as they are found in the three Mufcles ; thro' which, at the Groin, there goes the Tube W, thro' which the Seminal Veffels in the Males, and the round Ligaments of the Matrix in the Females do pafs; and confider whether fuch neceflary things as thefe are placed there by Chance.

Sect. XVIII. The Voluntary and Spontaneous Motions of the Inteftinum Rectum.
To add fomething more to what has been faid above, and which feems to me fufficient not only to fettle a Sceptical Mind, but even to convince an obfinate Atheift; let both thefe unhappy Men feriounly confider, that in this great Length of the Tube of the Bowels, which is continued from the Vol. I.

E

Stomach to the Inteftinum ReEtum, no body can increafe or diminifh the Contractions or Wringings of the fame; infomuch, that all thofe Motions (whereby that which is in the Bowels is protruded and difcharged) are quite out of the Power of his Will; but if the fame fhould hase place likewife in the loweft Part of the Intefinume Rectum, Mankind could never have any command over their Natural Eracuations, in order to retain or difcharge them, as occafion Phould require. And can a Man yet doubr, whether there be 2 GOD that has wifely and graciounly order'd all thefe things, when he perceives, that in the whole Structure of the Bowels, it is the Inteftinum Rectum only, into which Nerves are derived from the Medulla Spinalis, or Marrow of the Back-bone; yea, that the Motion of that Bowel alone is fubject to our Will, for the Prevention of fo many Inconveniencies, which it would otherwife be impoffible to avoid!


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## Contemplation $\quad V$.

Of the Venx Lactex, and Ductus Chylicus.,

## SEct. I. Ibe Tranfition.

AFTE R having traced the greatef Part of the Food as low as we could, let us now turn back again to the Stomach, in order to obferve the Ways and Paffages by which our merciful Preferver has been pleafed to conduct the Chyle or Nourifhment that is extracted for our Food, in order to prepare and render it more ufeful for making good what is wafted in our Bodies.

Not to mention in this Place the curious and skilful Structure of the Gall-Bladder, and the Veffels, which coming out of that, and of the Liver, do continually introduce a great Quantity of Gall into the Duodenum, where it mixes irfelf with the Food that is fent thither thro' the Pylorus from the Stomach; but more particularly, as often as by the drawing in the Breath, the Midriff defcending, preffes upon the Liver, and thereby fqueezing the Gall-Bladder (which lies within the Liver) forces out the Gall through a Veffel that reaches from its Bladder to the Inteftines. To fay nothing here of that Liquor that proceeds from the Pancreas or Sweetbread (a great Gland lying under the Stomach) which mingles itfelf with the extruded Gall, about four ot five Fingers below the Pylortis, or lower Orifice of the Stomach, and moftly by the fame Paffage.

Not to enter here upon enquiring into the Ufes of both thefe; whether, for inftance, they ferve together to feparate the Chyle from the groffer Parts of the Food; or to preferve the fame from Corruption by the Bitternefs of the Gall; or to render it more fluid; or to incorporate thofe Parts of it which cannot otherwife be eafily mixed, fuch as the fat and watry Parts; or to qualifie the Bitternefs of fome by the others; or for any other Purpofes, which, by a more nice Enquiry into the Nature of them, are daily difcover'd: But feeing that the determinate Ufe of each of the has not yet been decided, we fhall confine ourfelves to thofe things only, from which we can draw fuch undoubted Conclufions, as are more than fufficient to prove abundantly the Perfections of our Maker: Since that which is ftill unknown and uncertain, will remain to us a continual Object of Enquiry, and of Aftonifhment at his Wifdom, which does fo vaftly exceed our own.

## Sect. II. The Venx Lactex and Receptaculum Chili in a Dog.

To proceed then : If there were no Lateral Orifices or Openings in the Membranes of the Duct of the Inteftines, (as there are none in the Throat, for inflance, and Stomach) the Chyle or Juice, which becoming Blood fuftains the Body, would be difcharged at the fame time, together with the groffer Parts that pafs thro' them ; and Mankind would confume away and die for want of Nourifhment. Can it therefore be thought, that this likewife is meerly accidental ; that in order to prevent the fame, there lies in the Mefentery G G, (Tab. I. Fig.6.) befides the Blood Veffels I I, and the Nerves $m m m$, which pafs thro ${ }^{3}$ it, another kind of very narrow Veffels $l l$, which, when a Creature

Creature has continued long without eating, are quite invifible, but if you diffeat them a few Hours after it has been fed, they appear as little Veins full of a white Matter like Milk; from whence it is alfo, that they take the Name of Milky Veins, (Vena Lactea.) Thefe little Tubes open into the Inteftines L L, which by their contracting and protrufive Motions, do fqueeze out the thinneft of the Food, or prepared Chyle in thefe Milky Veins, under the Form of a white Subftance; which (in Dogs, according to this Figure borrowed from Verbeyen) takes its way, firft towards a great Gland K ; but in Men, by feveral other fmaller Glands; fince, according to the faid Verheyen, this great Gland is not found in them. Thofe that defire to fee the Defcription of the Mefentery in a Man, may be pleas'd to confult the 18 th Table of the faid Author, where the Glands are reprefented by the Letters $a a$ in the $2 d$ Fig.

We fhall fay nothing of thefe Glands, becaufe Anatomitts ase not as yet entirely agreed about the Ufe of them; only 'tis known that this Chyle is difcharged into a large Receptacle $\mathbf{O}$, by the Vena Lactea (Tab. I. Fig. 6.) coming from this Gland: The Anatomifts call it Receptaculum Chyli, or Cifterna.

SECT. III. The Receptacle of the Chyle in Humane Creatures.

It muft be remembred, that in this Figure the Courfe of the Veffels is reprefented as it appeared in Dogs, forafmuch as they are feldom to be fhewn in Men, who cannot be fo foon open'd after their Death. However, they that defire to fee a true Defcription of thefe Parts, as they lic in Humane Bodies, may find them in the Leipffck Tranfactions, p.57. Anno 1699. extracted from an

Englijb Book of W. Cooper, confifting particularly in the following Differences: (1.) That the great Receptacle of the Chyle, reprefented here by the Letter O, is compofed in Men of three large Tubes and Parts. 2. That the Links of the Chains that are here defcribed at S , (in the Tube O s, which runs upwards, and is called the DuEtus Chylicus, or Thoracicns) are obferved to be more numerous or various in Men. Rohault does likewife make mention of one that is found in a Man.

## Sect. IV. The Courfe of the Chyle to the Heart.

To return: In this Receptacle O, the aforemention'd Food mixes itfelf with another Humour, Water, or Whey, which the Anatomifts call the Lympha; and which having performed its Service to the Body, is continually derived this Way by the Vafa Lymphatica, or Water-Veffels; and then this Chyle and Lympha purfue their Way together upwards thro' the Belly and Breaft along the Back-Bone, from the Receptacle of the Chyle O, thro the Ductus Chyliferns $r r$; and finally are dif charged at $u$, in the Vena fubclavia $u x$.

The Blood running from $u$ to $x$ in the faid Subclavia, goes from thence thro' $x \mathrm{~B}$, called the Vena Cava, or Hollow Vein, to the Heart A; from whence the Chyle and Lympha being mingled with the Blood in $u$, are carried round with its Stream throughout the whole Body, in order to the Nourifhment thereof.

Now can any one fuppofe, that the Structure and Difpofition of fo many Veffels, fuch as the Vena Lactea ll, the Receptaculum Cbyli O, and itsDuctus rr, are produced by Chance? Can it be without Defign, that the Vafa Lymphatica $q q$ and $t t$, do difcharge themfelves in the two laft mention'd Receprasles and Ducts, to make a perpetual Stream, in order order to convey the Chyle with greater Conveniency to the Blood in the Vein $u x$ ? Of all which, if any thing fails, or is deficient, a Man runs the Rifque of lofing his precious Life. Is it without Wifdom that the Creator is pleafed to divide the Receptacle of the Chyle O, into three Tubes in Men, which in Dogs and other Creatures is but one large one? To the end, that in Men, who walk erect, the great Quantity of the Liquor fhould not eafily burft the Membrane that compofes the Receptacle O , and which is unconceivably thin and fine.

If all this be not yet fufficient to convince any one, let him attend to that which follows concerning the Valves, which will lead him as it were by the Hand to an Almighty and All-wife Creator.

Sect. V. The Valves in the Ductus Chyliferus, Venx Lactex, and Vafa Lymphatica.

Can we not again vifibly obferve a fix'd Purpofe and Defign of bringing the Chyle to the Blood and Heart? Which otherwife, together with the Lympha in the Ductus Chyliferns rr, (Tab. I. Fig.6.) ought naturally to defcend, by reafon of the ereat Pofture of Men : To prevent which, it is moft wonderfully provided by the Great Creator, that there fhould be Valves in the faid Tube or Dutius, which are opened by the Chyle when it proceeds upwards from $O$ to $u$, and fo takes its rightCourfe, but are fhut by the fame, if it fhould attempt to go backwards and defcend; juft as we fee in the Gates of Sluices, which, as the Water comes one Way, are open'd without Trouble, but fhut of themfelves on the other Side, by the Flux of Water againft them.

$$
E_{4} \quad \text { And }
$$

And there being a Danger that the Liquor in the Vena LaCtea 11 , and in the Lymphatica $q q$, fhould defcend and go backwards by its own Weight, the like kind of Sluices or Flood-gates are placed in both of 'em.

Among the Lymphatic Vefiels, the Ductus Chyliferus iffelf $r r$, mult be reckoned, fince it is likewife continually full of this Water, or Lympha, when there is no Chyle mingled with it; and fince, as we have faid before, it has alfo its Valves, the Figure of which may be feen in fome meafure in Tab.II. Fig. 2. at $c c$ and $c c$, and which are in like manner opened by the Liquor that runs from $a$ to $d$ : But if the fame Liquor fhould run backwards from $d$ to $a$, they would be clofed thereby.

## Sect. VI. The Protrufion of the Chyle.

Now if it be further obferved, that this Veffel is exceeding tender, for which reafon it is likewife guarded by the Pleura, or Membrane of the Ribs; that it has no fufficient Fibres for protruding the Liquor contained in it when neceffary (which Fibres do for this purpofe abound in the Inteftines and Arteries) but that neverthelefs the Procefs of this Liquor is fo neceffary towards the Prefervation of our Lives, that they could not continue without it ; ought we not again to ftand amazed at the Wifdom of the great Creator, who in this cafe has been pleafed to ufe a fingular Method to drive this Liquor upwards, caufing for that Purpofe the great Artery C, (Tab.I Fig. 6.) to run along the fame; placing the Intercoftalis c cc, as alfo the Artery of the Reins $D$, above and acrofs the fame, which fwelling at every Pulfe of the intruded Blood, do as often prefs upon this Tube; and the Liquor thereof being hindered by the Valves from going
backwards, muft neceffarily move forwards and upwards; to which likewife, the Tendons of the Midriff, which are drawn up in breathing, and which alfo prefs upon this Tube, do feem very much to contribute?

Is it not now very plain, the Motion being performed after this manner, how necefiary thefe Valves are, fince without'em the Preflure might as well force the Liquor downwards as upwards? It does likewife appear, why they are placed fo clofe to each other, and are more numerous here than in the Veins, viz. that the Liquor fhould be immediately ftopp'd as it endeavours to return; whereas otherwife, if the Tube between the two Valves fhould be very long, it might caufe it to fwell fo much, by reafon of its Tendernefs and Length, that there would be not only a Danger of burfting, but the Motion or Courfe of the Liquor would likewife become too flow.

## Sect. VII. The Valve in the Vena Subclavia:

Here is yet another Inftance of the wonderful Wifdom of Divine Providence, tho' it feems to be but a fmall matter; namely, that this DuEtus Chyliferus $r r$, difcharging its Liquor at $u$, into the Subclavian Vein $x$, is covered at its Orifice with a little membranous Valve in the Shape of a HalfMoon; which does hinder, in the firft place, the Blood from defcending from the Vein $u x$ into this Ductus Thoracicus $r r$, and fecondly, is the Caufe that this little Membrane, being only open exactly on the Side $x$, the Way that the Blood runs, the Chyle coming out of it is thereby immediately carried along with the Stream thereof; whereas, if it had been open on the other Side, the Blood by its ftrong Circulation would prefs into this Veffel $r r$, and fo hindering the Chyle from

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from going forwards, would put an end to our Life.

I cannot forbear reprefenting this laft Matter in Tab. II. Fig. 2. which is borrowed from the Accurate Dr. Lower : $d b$ and $c a$ is the Ductus Cbyliferus, cs the Valves, which are here more vifible, becaufe the Chyle being fqueezed backwards with the Finger from $d$ to $b$, againft the faid Valves, makes the Tube fwell in that Part, leaving the other $b d b$ empty. But that which is moft remarkable in this Figure, is the little Semilunar Valve $i$, which covers the Orifice $b$ of the Ductus Cbyliferus in the Vena Subclavia, after fuch a manner, that the Blood flowing from $f$ to $g$, and fo on to the Heart, is hinder'd from forcing its Way into the Chyle-Veffel d $a$, and yet admits of a free Paffage for the Chyle and Lympha, as they run from $a$ to $b:$ : is the JugularVein, the Blood of which defcending into the Vein $f g$, renders this little Valve $i$ fo much the more neceffary.

## $\mathrm{S}_{\mathrm{ECT}}$. VIII. Convitions from the foregoing

 ObServations.Is there then occafion for any farther Proof of the adorable Wifdom of the Creator, than what has been juft now produced? And can any Man be fo far miftaken as to afcribe all this to Chance, or ignorant Caufes! For if each of thefe ${ }^{\circ}$ things were not made for that very End of carrying the Chyle and Lympha up to the Blood, and thereby preferving the Life of a Man, why are the little Vaives placed there? Why are they all open on the fame Side? Infomuch, that if among the great Number of them, any one fhould fail in performing its Work, there would prefently be an End of Life. Once again : If any one fuppofes that that all this depends upon Chance, why does he not think the fame of the Sluice-Gates for WaterMills or other Ufes? For I cannot believe that any one would dare to affirm the fame of a common Sluice (which neverthelefs has only the StruEture of but two of thefe Valves) that it was made without Knowledge or Skill ; to fay nothing of the amazing Structure of fuch an innumerable Company of Sluices following one another, and adapted to one and the fame Purpofe, as in the Cafe of thefe Tubes.

After all this, if a Man feriounly reflects, that upon the Structure of fo tender a Veffel as the DuCtus Chyliferus a d, (Tab. II. Fig. 2.) upon theDiforder of fo friall and not lefs tender Valves $c c$; upon the Inflection towards the wrong Side of thefe Valves, which are compofed only of a thin, moift and flabby little Membrane; efpecially upon fuch a little worthlefs Inftrument as the Valve i appears to be (which covers the Orifice $b$ of the Duitus Chyliferus, where it is inferted in the Vein $f g ;$ ) and laftly, upon the Diforder not only of all thefe together, but of any one of thefe fo fmall and feemingly contemprible Particles, our precious Lives are entirely depending; and if but one of 'em all fhould fail to perform its Function, fo valuable a Creature as Man is, would prefently curn to a putrifying Carcafs : Muft not every one confefs, that he is formed after a moff fearful and wonderful Manner! And ought we not daily to worfhip our great Preferver with the moft grateful Acknowledgments, for his having vouchfafed to preferve fuch fine and fuch delicate Parts of the Body, all of them abfolutely neceffary to Life, fo long and in fo good a State and Condition? So that the Pfalmift of Ifrael had great Caufe to fay, Pfal. cxxxix. v. 14. I will praife thee, for I am fearfully and that my Soul knowetb) right well.

The Manner in which the Pfalmift here expreffes himfelf, has often feemed to me meerly hxperbolical ; for if we contemplate the Human Body in its external and vifible Structure, as to its Strong Muscles, Hard Bones, Solid Inteftines, Tough Tendons, Ligaments, Membranes, \&c. it does not appear to be fo fenifully made, beyond other natural Things: But having more ferioully reflected upon the abovementioned Matters, and others of which we fhall treat hereafter, and weighing their Ufefulnefs towards the Prefervation of our Lives, which is much greater in thefe than in moft of the other folid Parts that were known to the Antients, this ftrong Expreffion did not appear to me a jot greater than the thing itfelf really deferv'd, and convinced me moreover of the Divinity of the Text, fo emphatically treating of thofe things which have been but lately found out by our learned Anatomifts, and confequently that they muft be known to him that indited it, tho' concealed from all the World befides.

Let it not therefore be thought frange, that the Holy Gboot does here fo peremptorily afcribe the Praife to God alone in this Cafe; fince no fecond Caufes, nor any human Skill, or Art, has in the leaft concurred towards the Support or Prefervation of fuch tender Parts in their proper State and Condition.

Every one knows how neceffary all this is, not by remote Confequences, but in itfelf, towards the Life of Men or Beafts. And what Phyfician is there in the whole World, whofe Knowledge can penetrate fo far, as to inform us of the fmalleft Signs and Tokens of the Difrangement of thefe Parts? I never faw nor read of any Sur-
geon that pretended to re-eftablifh any of them, when difordered or difplaced ; or to go yet further, that ever will be able to find out any thing fit for that Purpofe. If but one fingle Valve of the Ducfus Cbyliferi were obftructed, and could not open itfelf (which would caufe our Bodies to wafte away) what Writer has, or can fuggeft any rational Method of curing fuch a Diftemper ? Are we not then fearfully, yea, exceeding fearfully made, when the mof tender and niceft Parts can be the moft eafily diforder'd, and when once it fo happens, can never be put into their proper Situation again, but will occafion unavoidable Death : Add to this, That we can never difcover the Danger of fuch Diforder, fo as to be able to obviate the fame in any manner.

May we not be faid to be wonderfully made, when (to fay nothing of fo many Particulars, of which mention is made elfewhere) we find that fuch fmall, weak, and tender Inftruments, as are thefe Valves, are able to perform their Functions for the Space of 60,70 , or 80 Years together, without being worn out, or fpoil'd? Whereas no body that knew their delicate Structure, unlefs he found it experimentally true, in the Bodies of old Men, would dare to maintain that they could continue in the Difcharge of their Office, without any Diforder, hardly fo many Months.

How often do Clocks, Mills, and other moving Machines ftand in need of being adjufted by a skilful Mafter? And ought not this to teach every one, that a great Director does fupport and maintain all thefe things in that neceffary State, towards which all Creatures, all the moft skilful Phyficians, all the moft learned Philofophers, or the moft ingenious Artificers, cannot contribute the leaft in the World? And how can any Man forbear charging himfelf with the utmoft Unreafonablenefs,

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fonablenefs, who feeing fo great and important a Work, as is the Life of Men and all other Creatures, carried on by fo fimple, and, in appearance, contemptible Means, does neverthelefs perfift in afcribing it all to meer Chance, or ignorant Caufes! And being fenfible how much Good is thereby daily produced in himfelf (concerning which he is forced to own, that he not only gave no Direction, but, which is more, that he had not the leaft Perception ;) muft he not pronounce himfelf both ungrateful and worthy of Condemnation, as often as he refufes to acknowledge the Mercy and Goodnefs of his Benefactor, and even his Wifdom alfo, in the midft of fo many Wonders?

# Contemplation VI. 

Of the Heart.

SEct. I. The General Ufe of the Heart.

LET us now go on, and trace the Chyle or Food (which, as we have juft now fhew'd, is mingled with the Blood at the left Subclavian) quite to the Heart; in the Structure of which there do occur fo many wonderful Things, that one would imagine that none but a very unhappy or obftinate Perfon, feeing and comprehending the Compofition of this Organ, could help being convinced of the Wirdom of the Great Creator, and of the determinate End to which it is adapted, viz, the Reception and Expulfion of the Blood, (whether there be other Ufes of the Heart, I fhall not here enquire) to the end, that the Blood by this Motion, having perfected its Circulation thro' the Lungs, and thro' other Veffels, to all the Parts of the Body, and performed feveral other Functions in other Places, might return to the Beginning of its Courfe, that is, to the Heart and Lungs.

## $\mathrm{S}_{\mathrm{EC}} \mathrm{T}$. II. The Defription of the Heart.

The Heart has two Cavities, or Ventricles, feparated from each other by a thick flefhy Wall, or Septum, whichevery one may fee, that will take the trouble to cut acrofs the Heart of an Ox or Sheep.

The Heart, at the upper part of it A, (Tab.II. Fig. 3.) is thick, but at the lower part B, much flenderer ; the Shape of it is like that of an inverted blunt Pyramid; it is faftened, and hangs by its Veins and Arteries E F G HI; E is the Vena Cava, or hollow Vein by which the Blood defcends; G is the Vena Arteriofa, or Arteria Pulmonaria, (the Pulmonic Artery) thro' which it: paffes out of this Ventricle into the Lungs; and His the Arteria Venofa, or Vena Pulmonaria (the Pulmonic Vein) thro' which the fame Blood returns from the Lungs into the left Ventricle of the Heart ; out of which it is carried by the Aorta, or great Artery I, to all the Parts of the Body; C is the Right Auricle of the Heart, into which the Blood paffes from E and F , before it falls into the Right Ventricle; D is the Left Auricle, which performs the fame Function to the Left Ventricle; K K are the Arteria Coronaria, and the Vena Coronaria, which feed the Heart, and provide it with Blood.

## Sect. III. The Eminence or Protuberance in the Vena Cava.

Bu T here the Stream of Blood defcending from the Vena Cava at E, meeting with another Stream afcending at F , feems to threaten the apparent Danger of thefe two Currents rufhing againft each other, either within the Ventricle or Auricle of the Heart; for that Blood which comes down from E, affifted with its own Weight, and having therefore a greater Strength, might hinder the other, which coming up from $F$ runs againft it, from purfuing its Courfe; and fo the Circulation of the Blood, and therewith the Life itfelf, might foon come to an End.

Now to prevent thefe Inconveniencies, that would otherwife be fo dangerous, we find that between thefe two Veins E and F, (both which are reprefented at A A, Tab. II. Fig. 4. where they are laid open) there is a Protuberance B, com $>$ pofed of the Fat that lies under, againft which the Blood defcending from E, runs or ftrikes, and by that means the Courfe of it is turned to the Right Auricle of the Heart ; whilft the Blood afcending from F, is by the faid Protuberance B covered and fecured againft the oppofite Courfe of the defcending Blond, and fo is obliged to turn its Courfe afide to the Ventricle of the Heart.

We muft likewife here obferve, that this Protuberance B is much greater in a Man (becaufe in confequence of his erect Pofture, the upper Blood at E defcends exactly perpendicular) that it is in Dogs, Horfes, Cattle, and the like Creatures, in which the Courfe of the Blood at EF is only Horizontal, and therefore does not move with fo great Force.

Once again : How very wonderfully are we made! And can any body fee, without terrible Emotions, that as our precious Life in the Ductus Chiliferus, does entirely depend upon fuch flender and minute Vaives, fo it does here upon fuch a frall Protuberance as is defcribed at B ? If here were no exprefs Defign of the adorable Creator, why do we find it juft in this Place? Why is it bigger in a Man, where there is a Neceffity in Nature for its being fo, to balance the Force of the defcending Blood ; and lefs in fuch Creatures where fuch Balance is not wansing to perform the fame Service?

> Vor. I.

F
SECT

## S e ct. IV. The Auricles of the Heart.

Furthermore, the Courfe of the Blood, which continually paffes thro' thefe Veins A A, feems to require, befides the Heart, another Reft-ing-place to be contained in, during the Time in which the Heart contracts itfelf in order to difcharge the Blood, and while the Valves of the Orifice of the Right Ventricle are fhut ; to the end that it might be there collected in the mean time, and as foon as the little Valves are again open, be fwiftly emptied into the Heart ; for which Purpofe the Auricle C, (Tab.II. Fig-3.) ferves on the right Side of the Heart, as $\mathbf{D}$ does on the left, which whilft the Paffage thro' the Valves is ftopt, are full of the Blood that runs into them, and are provided, after a wonderful Manner, with Mufcles and other Inftruments, by which means each of them can fwiftly contract itfelf as there is Occafion, and lofe no time in the fudden Difcharge of the Blood into the right and left Ventricles of the Heart.

## Sect. V. The Operation of the Heart.

The Blood being now come thither at the time when the Heart does as it were loofen and open itfelf (I do not here difpute whether there be a Faculty in the Heart required for that Purpofe) it contracts itfelf fuddenly, and with great Force ; infomuch, that the fides of the Right Ventricle approaching each other by fuch a Contraction, and the upper and lower Ends thereof being likewife drawn tegether, the whole Cavity is in a manner clofed, and the Blood thereupon driven out with great Swiftnefs into the Lungs thro, the Pulmonic Artery, or Vena Arteriofa G, (Tab.II.

Fig. 3.) and goes onward thro' the Pulmonic Vein, or Arteria Veno $f_{a} \mathrm{H}$, to the Left Ventricle of the Heart, after it has been diftributed thro' the Lungs.

One may have a grofs Conception of this Working of the Heart, by comparing it to a Bellows full of Water, in which there are two round Holes ${ }^{2 t}$ Top; the one of which, upon the Clofing or Contraction of the Bellows, is ftopt with a Valve, whilf the other remains open; now, in cafe you fhould with a fudden and violent Motion prefs the Sides thereof together, fo that in a Moment, or in the time of one Pulfe, the whole Cavity thereof were taken away, it can fcarce be imagined with how great Swiftnefs the Water in the Bellows would fpring out of the Orifice which remains open : And this is a rough Idea of the Manner in which the Blood is fuddenly extruded from the Right Ventricle of the Heart into the Lungs.

## Sect. VI. The Courfe of the Mufcular Fibres.

Now in order to perform this fo fudden and violent Contraction, or Syfole of the Heart, the Mufcular Fibres of which it is compofed, are fo wonderfully and fo peculiarly adapted to this very End, that he who is not wilfully Blind, and under a deplorable Hardnefs, muft herein neceffarily difcover the Hand of a Wife and Defigning Creator. That this is not faid without good Grounds, will appear plainly enough to fuch as pleafe carefully to confider the Courfe of thefe Fibres.

For you may fee firf, the Fibres, A and B; (Tab.II. Fig. 5.) running obliquely from Top to Bottom, and others defcribed by C and D, croffing the former; both thefe oblique Fibres being contracted in their Operation, the Cavities of the Heart mult
become narrower, and both its Ends in fome fort likewife drawn together. Befides thefe, there are other Fibres that lie above them, and run freight upwards, (Tab. II. Fig. 6.) which only belong to the Right Ventricle, and by contracting themfelves, do fhorten the fame. But the Courfe of the Fibres, that perform the fame Work in the left Ventricle, is wonderfully furprifing; for thofe A B, (Tab.II. Fig. 7.) running on all fides from Top to Bottom, encompafs the Heart at the Point C, and being contracted, draw the fame upwards towards A: Thefe Fibies are reprefented upon the faid Point or fharp End, as you may fee Tab. II. Fig. 8.

Now, in order to affift the lateral Contraction of the oblique Fibres, we may obferve a row of other Fibres, A C B, (Tab.II. Fig. 9.) running under the oblique ones, which perform their Function, by encompaffing the Heart crols-wife, and contracting the fame; fo that here is in a manner the like Difproportion of Mufcles as has been fhewn above, in defcribing thofe of the Belly : This whole Matter is largely treated of in that little, but accurateDifcourfe of the Learned Dr. Lower.

Let any Body now that underftands thefe Things, feriounly confider with himfelf, whether it be poffible, that fuch a variety of Rows of Fibres, endowed with fuch a great Strength together (as has been demonftrated by Borelli) and all ferving to that very Purpofe for which the Heart feems alone to have been form'd; that is to fay, by its Contraction, to protrude the Blood it has received into the Arteries joyn'd to it ; I fay, whether all thofe Fibres can have acquired this wonderful Difpofition, without Wifdom and without Defign?

Now, fince there are not hitherto any other Mufcles difcover'd in the whole Heart, fave thofe that contract it, and render its Cavities narrower ; is this likewife by Chance, that the Fibres thereof
when once contracted, are not fuffer'd to continue in the fame Condition, but prefently dilating themfelves, do open the Cavities, that they may again receive the following Blood out of the Veins, and by the repeated Contraction of the Heart, diftribute it to the Lungs and other Parts continually, and as long as our Lives do laft?

## Sect. VII. The AEtion of the Valves of the Veins?

There fill remains anotherDifficulty in the Ufe of the Heart, viz. that (fince each Ventricle has two Orifices, one by which the Blood enters, and the other, by which it goes out again) it feems to be a Confequence thereof, that the Hearc being fo fuddenly and ftrongly contracted, the Blood fhould flow at once out of both of 'em, and fo be forced backwards by the fame Paffage by which it enter'd into this Ventricle.

To prevent the fame, the wife Power of the wonderfu! Creator does again appear, who for this Purpofe has been pleafed to place there another fort of Valves (which, by reafon of their Triangular Figure, the Anatomitts call Mytrales, becaufe they reprefent aBifhop's Mitre) in that part of both the Veins, thro' which the Blood is difcharged into the Heart; and thefe, when the Heart contracts itfelf, and the Blood is thereby driven towards the Orifice, in the Circumference whereof they are placed, are thereby thut very clofely : Thefe Valves (which we can hardly look upon without Amazement, if we confider the Providential Views of the Creator) are faften'd to the Sides of the Ventricles with a great many tendinous Fibres, that are very ftrong, in order to fecure the Valves when they are fhut, like fo many Bars and Chains upon Doors, to the end that the Force wherewith the Blood that was fqueezed out of the

Ventricles acting againft them, may not break them open, or bend them in fuch Manner on the other fide, as to mak a Paffage thro' them for the Blood; efpecially, confidering that they are compofed only of thin and flexible Membranes, and not of Bones or other folid Matter.

Thefe Tendinous Fibres, have moreover the following remarkable Ufes: Firf, That as the Heart after its Contraction, does again dilate it felf and become longer, and confequently the Sides of it, which were raifed upwards, do fink down again; I fay, the faid Fibres being faften'd to the Sides, draw the Valves open (as is done in the Gates of fome Sluices with Ropes) in order to make a free Paffage for the returning Blood. Secondly, That thefe Fibres are faftened in fuch a manner to forme little Protuberances, or Pins of the Sides of the Heart, and even to the oppofite Side alfo, that they can hinder thofe Valves from falling down flat, or from touching the Sides of the Heart, to the end that the Blood, in the Contraction of the Ventricle, may prefs againft thefe Valves continually from below, and fo raife them upwards, in order to clofe their Orifices.

SECT. VIII. Convictions from the Foregoing Obfer-
vations.
I HAVE given an Account of the chiefeft of thefe Matters by Words only, without adding any Figures to them ; having found in the mof accurate Books of Anatomy, that the beft and moft exact Figures taken from the Original, are not capable of giving much Light, by reafon of the vaft Number of Particulars that are obfervable thercin, to fuch as have not vicwed the fame in the Heart of any Creature; for they would require more Study and Application to be under flood,
flood, than even the Structure of the Heart itfelf. They that would make a Tryal thereof, may confult the Fourth Figure in the 14 ih Table of Monficur Verbegen, and the Firft Figure in the sth lable of Dr. Lower.

Farther, if there were any known Machine to be met with, the Operations whereof had any Analogy or Similitude with thofe of the Heart, the Defcription of it might, perhaps, render this Account a little clearer ; but neither Pumps, not any kinds of Spouts, no, not even the modern Engines for quenching Fircs (tho' in the opening or flouting of their Valves, they may feem in fome manner to imitate the Heart) nor any thing elfe that Art has yet been able to produce, can any-wife come near them, to reprefent the gieat Wifdom wherewith this wonderful Machine of the Heart is formed. Can any Man then imagine, that this great Work has been made by Chance; when no Body dares affirm the Came, even of all thofe other imperfed Machines that have been mention'd above?
Having oftentimes meditated upon thefe Things, I have thought with myfelf, bow fearfully and wonderfully we weve made, as upon two other occafions has been mention'd before; for in cafe one of thefe Valves floould be out of order, and unfit to perform its Function; yea, if one of thefe little Fibres, which are faften'd to the Valve, and draw it up, fhould break, or be either too fhort or too long, thefe little Sluice-Gates could not be fhut, as not being able to come upon each other, if the Fibres were too fhort ; or if too long, not able to remain fo, but forced to give way to the Preflure of the Blood; infomuch, that not only upon each of chefe little Valves, but, which is yet more amazing, upon the various Length of thefe fine Fiboes, the Life of fo Artful a Machine as cvery Man is ; felves, and of all Creatures whatfoever, do entirely depend.

## Sect. IX. The Valves of the Arteries.

THIs being faid of the Orifices, thro' which the Biood paffes into both the Ventricles of the Heart, there was yet danger, that when the Blood was protruded from the Right Ventricle into the Artery of the Lungs, and out of the Left into the great Artery, the Heart opening itfelf again, and the Expulfive Force ceafing with the Syfole, the Blood by its Weight might go back into the Ventricle of the Heart from whence it came, and fo by obftructing the Circulation, caufe immediate Death.

But here the Care of a moft merciful Creator has interpofed, by placing other Valves again at the Beginning of both thefe Arteries, which perform juft the contrary Function to the foregoing ; fo, that as the former were fhut by the Blood that endeavour'd to afcend from the Heart, thefe are fhut by that which defcended to the Heart : And, whereas the firft were open'd by the Blood that ran to them, the fame is effected in thefe, by the Blood that iffues out.

That this may be more cleariy conceived, let (Tab. II. Fig. io.) a a reprefent the open'd Part of the Left Ventricle of the Heart; $c$ the great Artery diffected lengthwife; $66 b$, the three Semi-lunar Valves, which are fhut by the returning Blood : Here they appear lying flat and extended, whereas, otherwife they fill the round Orifices of the Artery; ff are the thrice Triangular, or Mitral Valves turned afide, that you may fee the other $b b b$, the better; and at thofe $f f$, one may oblerve the Fibres fg fill hanging, the Ends of which, gg, which they are otherwife faften'd, when in their natural State.

How thefe little Valves $66 b$, are difpofed by the Blood that is driven back, and how they fhut the Artery, may be obferv'd ccc (Tab.II. Fig. 2.) The Appearance is likewife the fame, if you blow into the Artery A; BB are the Crown-Arteries (Arteria Coronaria) which feed the Heart, and carry their Blood thither; the Openings of which into the Aorta, or great Artery, are reprefented in (Tab. II. Fig. IO.) d d, exactly above thefe Valves,

## SECT. X. The Lateral Mujcles of the Heart.

A ll the admirable Curiofities obfervable in the Heart, would be too many to be here nicely examined into. The Lateral Mufcles in the Right Ventricle of the Heart (to pafs by a great many other wonderful Contrivances in that Organ) feem here to require more particularly an immediate Attention; thefe Mufcles, holding the Sides of the Heart together, hinder it from being too much extended by the Blood that falls into it at each Diafole, and fo ferve for a Meafure of the Quantity that is to be poured into it at each time; they do likewife contribute to the bringing the Sides nearer together in the Syfole or Contraction of the Heart. Thus we likewife perceive, that the left Ventricle is encompaffed with, much ftronger Mufcles and Walls than the Right, which appears when you cut the Heart a-crofs; becaufe that this laft is only to convey the Blood thro' the Lungs, which bears no Comparifon with the Diftance (viz. the extreme Parts of the Body) which it arrives at by the Force of the Left Ventricle of the Heart. Whether this Force be wholly determin'd by the contracting ther the Arteries afford any co-operating Power towards this Motion of the Blood, is yet a Mat ter in Difpute: But this is certain, that whatevel Force conveys the Blood to the Extremities of the Body, contributes towards furnihing it there with the means of returning to the Heart by the Veins. If People cannot here difcover the Views and Defigns of their Great Creator, their Blind nefs is much to be lamented: Yea, ought not every one to ftand amazed, that fees fo much Swiftnels communicated to the Blood, by fuch a foft flefhy Inftrument, in order to perform fo great a CircuJation in fo fhort a time?

Sect. XI. The Force and Power of the Heart, reprefented by Comparifons.
$\mathbf{H e}_{\mathrm{E}}$ that doubts whether the Syftole of the Heart is a Force fufficient of itfelf to bring about fuch a Circulation, may, without Mathematicks, obferve how great a Force and Swiftnels is performed by the Compreffion of two Bodies, by taking a Cherry-ftone, and fuddenly fqueezing it between his Fore-finger and Thumb, which will caufe it to fly out more fwiftly than a Perfon never making that Obfervation cou'd eafily imagine: By taking a Handful of wet Clay, and compreffing it fuddenly, as the Heart does the Blood, another notable Inftance offers itfelf; for, by obferving how nimbly the Clay burfts out wherever there is a Paffage for it between the Fingers; and, confidering at the fame time, that this Clay has five Places to come out at (three between the Fingers, one at the Top, and another at the Bottom of the Hand) this Conciufion (which illuftrates the Motion of the Blood from the Heart) naturally refults; viz. that if the Clay iffued out only
only thro' one Paffage (inftead of five) the Velofity wou'd be five times greater. After the fame nanner the Spittle which is produced in the Mouth by fmoaking Tobacco, is difcharg'd with great Swiftnefs : This is perform'd by collecting the Moifture into a Cavity between the Tongue and Lips, which Cavity they afterwards deftroy, by thrufting the Tongue againft the Lips, and fo force the Spittle out. One might inflance in other Cafes, but this is fufficient to reprefent, in rome fort, the Purpofe in hand.

SECT. XII. The Pericardium, or little Bag of the Heart.

ADD to all this, that the Heart is preferved in a membranous Bag called the Pericardium; which, by furnifhing a Liquor from itslittle Glands (concerning this, fee Bergeus, Malpighius, \&c.) does continually keep the Heart fmooth, and fit to perform its conftant powerful Motions, hindring its external Membrane from being wrinkled by too much Drynefs; and it lubricates and moiftens the adjacent Mufcular Fibres, by which means this wonderful Inftrument is enabled to perform its neceffary Functions, which otherwife would be obftructed.

## SECT. XIII. Convitions from the foregoing Obfervations.

To fay no more; after the Contemplation of this Heart in all its above-mentioned Circumfances, can an unhappy Philofopher, even the moft ill-natured and obdurate Atheift, be eafy in mainraining, that all this is performed without Wifdom, without Defign, and only by ignorant Caufes? Since he cannot but know, that he would be taken
by all Men, and without doubt by himfelf too for a very foolifh Perfon, in cafe he durft affirm that a Fire-Engine only (which by no means i to be compared with the wife Contrivance anc Structure of the Heart) was produced by Chance and without the Concurrence of a skilful Work man. Let him alfo add, that this Machine is made and put into Motion by another, fo that the whole is performed in his own Body, not only without his Will, but even without his Know. ledge and Perception; and will he not yet fee that his dear and precious Life is preferved by another, who has fhewn fo great Wifdom therein How can any one conceive, that this Motion of the Heart, according to the Calculation of the famous Mathematician Borelli, muft be performed by the exerting of more Force at every Pulfe than is required to furmount the Refiftance of fome thoufand Pounds Weight? That fuch a Motion is performed above two thoufand times in an Hour, without ever ceafing, whether we wake or nleep, for the Space of fifty, fixty, or feventy Years perhaps? And particularly fince our other Mufcles, after much lefs Pains, and fometimes but in one Day, become fo tired and impotent, which never happens to the Mufcles of this little Heart in fo many Years. And cannot then fo great a Matter, brought about by fuch wonderful Inftruments, and after fo amazing a manner, convince every Man that is reafonable, and make him conclude with Certainty, that a Power far exceeding Humane Knowledge is here exerted.

Yea none can deny, that according to what we have juft now fhewn, that as often as he lays his Hand upon his Breaft, and feels his Heart beat, that this Motion is performed without his own Concurrence, and confequently by that of another.

And fince we have feen befides, by the foreoing Structure of the Heart and other parts, that his great Creator and Mover of all things is wife, nd that our Lives do entirely depend on thefe Motions produced by his Power: I fay, when Ill this is well confider'd, muft not fuch a Man remble, who does not only refufe to teftify his Gratitude to this mighty, wife, and powerful referver of his Life, but alfo dares openly blafheme him, and denies all his Attributes. and Perections?

## Contemplation VII.

Of Respiration.

Sect. I. The Air is neceefary to the Blood.

THOSE who have read the preceding Difcourfes are already informed, that the Blood difcharges itfelf from the Veins $\mathbf{E}$ and F , (Tab. II. Fig. 3.) into the Right Ventricle of the Heart; from thence it is introduced into the Lungs (by the Syftole of the Right Ventricle) thro' the Vena Arteriofa, or Pulmonic Artery G; and from the Lungs it is again difcharged into the Left Ventricle of the Heart, by the Arteria Venofa, or Pulmonic Vein H.

Now whether the Blood paffes from one of thefe Tubes into the other immediately, or whether it paffes thro' that Subftance of the Lungs which is of the Nature of Bellows, we will not here enquire ; this is certain, that the Air fuck'd into
into the Lungs where this Blood is, does, as long as Life lafts, come in and go out again; and whatever the Ufe of it be, it is fogreat, that no Man can want it a fhort Space of Time, without prefently dying; and it is no lefs probable, that the Inftruments by which the Air is conveyed into the Lungs, are made with great Skill and Contrivance.

## Sect. II. The Blood Veffels and Alpera Arteria

 in the Lungs.H. that doubts of this, let him take the Lungs and Wind-pipe of a Lamb, or any other Animal, in which may be obferved, I. That the uppet Orifice of the faid Wind-pipe can be covered with a fmall Cartilage, called the Epiglottis, whilft the Food is defcending thro' the Gullet that lies behind it, into the Stomach. 2. That whereas the Branches of the Wind-pipe, which fpread themfelves into the Lungs, are Cartilaginous, and of a Round or Cylindric Figure, that they may always remain open; yet the Wind-pipe itfelf, where it lies upon the Gullet, that it may not hinder the Paffage of the Air in the fore-part of it, does by its Cartilages compofe part of a circulat Figure only, and behind has only a membranous Covering, becaufe the Cartilages perceivable in the fore-part of the Wind-pipe, would prefs too hard upon the Gullet, thereby incommoding the Paffage of the Food. 3. The wonderful Structure of the Air-Tubes, or Branches of the Wind-pipe, (Tab. II. Fig. 12. A E) which paffing throughout the Lungs, lie between the two Blood-Veffels BE and CE; of which B E ferves for a Paffage to the Blood that enters into the Lungs, and CE to that which coming out of the fame enters into the left Cavity of the Hearr. The fame is obferved


arved to happen conftantly in thefe Lateral Branches; the Blood-Veffels being cut off here, hey are reprefented finer, and the Ramifications if Air-Veflels interwoven with them, are more ommodiounly defcribed.

## SEC T. III. The Glands in the Wind pipe:

But if it was neceffary to ufe great Care in he Formation of any Part of the Body, it feems o be moftly fo here, to the end that this Tube, which as long as we live, or whether we wake ir fleep, admits of a conftant Influx and Reflux of 4ir) fhould not by this Air grow dry. Is there hen no Defign to be traced and obferved here? Since the Omnifcient Creator has cloathed the ame on the infide not only with a Glandulous Membrane, from which a Humour is always fil trating, and in order to moiften the Throat itfelf, aas been pleafed to place two Glands called the Thyroidea, of a confiderable Bignefs, for that Ufe, befides thofe other Glands which we commonly name the Almonds, but further, to manifeft his inrended Purpofe more clearly, has planted in all thofe Places where the Air-Veffel is divided into Branches, very vifible Glands for the Moifture thereof; (whether they have any other Ufes befides, we are not now enquiring:) And forafmuch as the Epiglottis, by reafon of the continual paffing and repaffing of the Air that frikes upon it, feems almoft impoffible to be kept moiftened, and if it were dry, could not fo well difcharge its important Function ; can any one fee, without Aftonifhment, how the great and wife Contriver thereof, has furnifhed this Cartilage with fo many little Glands above and below, in order to moiften it beyond all others!
SECT.

Sect. IV. A Hindred Mufcles requifite toward. Refpiration.

Not to mention here the Divifions of the Wind-pipe into fo many Cartilaginous Rings, nor the Membranes and Fibres by which they are faftened to each other, nor the wonderful Structure of the Larynx, confifting of fo many Cartilages, and moved by fourteen Mufcles, to the end that by all this Apparatus, the Wind-pipe and its Orifice being feveral ways lengthened and fhortened, dilated and contracted, the Voice might be thereby formed, and yield a more flatill or deep Sound; which things being now become the Object of the Enquiry of feveral great Naturalifts, we fhall here confine ourfelves only to Refpiration; and content ourfelves with asking any one that does ftill queftion the Wifdom of his Creator, whether he can believe that the Inftruments, which, befides the Lungs, are neceflary thereto, could be ranged and placed near the others without any Underftanding or Defign ? Efpecially if it fhould be proved to him, that altho' the Midriff alone is fufficient for Refpiration, yet to the end that $\mathrm{f}_{0}$ neceffary a Work as this is, might not eafily be obftructed, about a hundred different Mufcles are likewife applied to the fame Purpofe; and, as ealy as the Action of breathing may appear to be, that in a ftrong Refpiration (when every one of this great Number of Mufcles, that are capable of being ufed therein, are employed for the Purpofe) before the Breath be drawn in and driven out again, this great Number of Mufcles muft have all been employed for that Purpofe.

This is fufficiently known to the Anatomifts; and, to give you a fmall Sketch of it here, we fhall inform you, that in drawing in the Breath, in
order to raife up the Ribs and the Breaft-Bone, and thereby to dilate the Cavity of the Thorax, or Breaft, there are put in Motion on the one Side, me Mufculus Subulavirs, eleven Intercoftales. Externi, Eleven Levatores Coftarum, befides the Serratus Anficus Minor, the Seriatus Anticus Major, the Serratus Pofticus Superior, and the Cervicalis defcendens Diemerbioekit, and three others which are therefore palled Common, becaufe they likewife perform other Motions, viz the Pectoralis, Scalenus, and Levaor Scupula, which together make thirty Mufcles mone Side; and there being as many more on he otlier, are in the whole fixty that are emloyed in Infpiration, or drawing our Breath inwards.

Towards Expiration there are likewife employd nineteen Murcies on a Side, eleven Intercoftales Inerni, the Triangularis, the Sacrolumbus, and the Serratus Pofticus Inferior, and with thefe alfo five Common ones, riz. the Mufcles of the Belly; thefe re altogether thirty eight Mufcles, ufed for Expiation only, which being added to the fixty above, nake together the Number of ninety-eight: Now F you add to thefe the Midriff, being the principal Inftrument of them all, and which, according oo the Opinion of that great Anatomif Verheyen, :onfifts of two, or it may be three Mufcles more, here muft, according to this Computation, be at caft a hundred Mufcles inade ife of in one fingle Action of Breathing as ftrongly as we can. Thefe Obfervations we find made in the AEFa Lipfienfia, Anno 1707, of Y. G. Pauli, upon Van Horne.
I would now ask again, whether any Body can uppofe that fuch a Difpofition, where there are io many Mufcles confiftirg of Fibres extended fo many different Ways, is produced by Chance, or without Defign? Or whether it does not plainly appear to him, that this great Compofition of

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the Mufcles is exprefly adapted to the end of Breathing.

Sect. V. Without Air this whole Struiture is ufelefs.
Bur if what has been here mentioned concerning the Difpofition of thefe Mufcles, fhall appear wonderful in every Man's Eyes, will he not yet ftand more amazed at the Wifdom of the great Director of all Things, when he finds that all thefe Inftruments, tho' never fo artfully adapted to Refpiration, would be yet in vain, and of no manner of Ufe, if Mankind, and all other Creatures breathing, were not furrounded with fuch a Matter as the Air is, which has in it, among other Properties, an Expanfive Power (Vis Elaftica) befides a Weight, which catufes it to operate and dilate itfelf; from whence it comes to pafs, that as foon as the Breaft is enlarged by the Operation of the above-mentioned Mufeles, this Air immediately ruflhes into the Wind-Pipe and Lungs; of which Property (taking it at prefent for granted) we fhall treat more largely hereafter, when we enter upon the Contemplation of the Air itfelf; and we thall prove experimentally, that in an Air which is but partially divefted of this Elaftic Force, almoft all Creatures will immediately perifh.

Sect. VI. The Pioperties of Expanded Air.
However, that we may here give you fome I dea of Refpiration, it will be neceflary to reprcfent previoully, I. That when the Place in which any Air is thut up, is made larger, the faid Air filling a greater Space, is fo much the more weakened in its expanlive Force. 2. If the Air thus weakened has any Communication with other Air that is ftronger, and both of 'em can act upon
each other, the ftronger Air will immediately rufh into the enlarged Place, in which the weaker was contained.

SECT. VII. The Comparifon of Refpiration with a Pair of Beliows.

To prove this by a Compárifon, one need only reprefent to one's felf a Pair of Bellows, (Tab. III. Fig. I. A E F) in which we know that nothing more is requifite in order to draw the Air into the Mouth A, or Tube A B, than to feparate the Sides E D and F G from each other; by which Means the Space E D G F is enlarged; and fo the Air that was contain'd therein being weaken'd, and not powerful enough to ballance the external Air, with which it had a Communication by the Tube A B, the laft being now become the ftrongeft, does by its Elaftic Force crowd itfelf into the Mouth of the Bellows.

The fame thing would happen, if one fuppofed that a Bladder B C were faftned to the Tube A B within the Bellows; in which Cafe the Space K being dilated, the Air therein would likewife be too weak to refift the Air which fills the hollow of the Bladder B C, thro' the Tube A B, by which means this Bladder will be blown up, and expanded by the ftronger external Air rufhing in upon it.

Now if you fuppofe the Tube A B to be the Wind-Pipe, the Bladder B C the Lungs, and the Space thereof E D G F the Cavity of the Thorax or Breaft, you will fee the Reafon why the Air rufles thro' the Wind-Pipe into the Lungs, to which it is faftened like thefe Bellows, when by preffing down the Midriff, and by the other Mufcles, the Brealt is made wider and larger.

He that defires farther to fee how the Lungs whilft hanging to the Wind-Pipe, may be puffec up by the Air, need only take the Trouble o blowing ftrongly into the Wind-Pipe of a Sheep or Ox newly killed, by which means he will fee thr Lungs, like Bellows, expanded by the Wind that paffes into them.

Sect. VIII. An Experiment ufon the Lungs it Vacuo.

I have reprefented thefe Appearances after fuct a grofs manner, to the End that thofe who have not the Opportunity of ufing the Air-Pump, may have fome Conception theteof; but thofe that havt ufed this extraordinary Inftrument, fo neceffary it examining the Works of the great Creator, may form to themfelves a much clearer and more diftinct Notion thereof.

Let the Covering O P be laid upon the Glaf! O P F, Tab. III. Fig. 2. ftanding upon the AirPump, which has a little Tube A N B paffinģ thro' the Centre of it, and a little Cock at N which now appears open, but may be fhut ; undet this Covering, at the Extremity of the little Tubs A N, there is another fcrewed on at B C, the Eng of which is Ituck into the Wind-Pipe of a little Piece of Lungs D , which is tied faft to it.

Now when the Piftcin or Sucker L M of the Air Pump is thruft to IK, or fo far inwards as poffibie, one fees that the Piece of Lungs D hangs in the Space E , that does not extend itfelf farthen than from OP to IK, when the Cock G H is open, in which Space the internal Air is fnut up; but the little Cock at N being turned, the Sucker is drawn backwards from I K to L M ; and ther: the Space that contained the included Air is fo much larger, as the Diftance between I K and

L M
L. M ; both Spaces being filled by the Expantion of the Air, which therefore lofes a great deal of its Elafticity: This will appear, if you open again the little Cock N , when the external Air rufhing into the Piece of Lungs D , thro' the Tube A B, blows it up; the Reafon of which is, that this Air having lof nothing of its Elafticity, prefles more ftrongly into the Lungs D from without, than the included Air at $E$, which preffes it in wardly, iş able to relift, becaufe of the weakniing of its Spring.

That this is true, will appear, forafmuch ass if you thruf the Sucker L M torwards to I K, and drive the included Air into a nartower Space, it will again ftrongly expand itfelf at E , and preffing with more Violence the Lungs D, will malic them become fmaller, by forcing the Air which was in them to go out again thro' the Tube B A; and this Effect you may produce as often as you repeat the Experiment, by drawing or thrulting the Sucker backwards or forwards. Now if you will fuppofe the Tube A B to be the Wind-Pipe, the Space O P K I to be the Cavity of the Thorax, and the Sucker L M the Midriff, there will be a mighty Analogy between that Experiment and the Bufinefs of Refpiration; and the whole Difference is only, that whereas the Cavity of the Thöax, in which the Lungs hang, is dilated and contracted by the Mufcles and ocher Initruments ; the fame Effect is produced in the Air-Pump, only by the Sucker thereof.

Now fuch as don't think it worth the while, or have not the Opportunity of making this Experiment with the Lungs of any little Animal, may ufe an empty Bladder $D$, tying the fame to the End of the little Tube B C , which will give them all the Appearances very conveniently and agrecably; fo that with but half a turn of the

Handle of the Air-Pump one way or other, the may fill or empty the Bladder of Air.

Sect. IX. An Experiment witth a little Bottle os Water.

Now if any Body has a Mind to fee with hit own Eyes, after what manner and how violently the Air crowds itfelf into the Lungs as foon as the Cavity of the Breaf is enlarged; inftead of a Piece of Lungs or Bladder, let him take a little Glafs Viol, holding about an Ounce or fuch like Quantity of Water, and tye it to the Tube B C: fo that the End of the Tube may be thruft as fat as it can into the Water, then fhut the Cock $\mathrm{N}_{3}$ and enlarge the Space as before, by drawing back the Sucker to L M; let him open the little Cock N , and he will fee that the External Air, which by its ftrong expanfive Faculty forced itfelf inwards, will put the Water into a very violent Motion, juft as if one fhould fet his Mouth to the ather End of the Tube A, and blow thro' the Water as hard as he can.

Sect. X. The Expciiment of a Syringe in Vacuo.
Now, in order to convince every one experimentally, that altho' a Space be enlarged, as happens in the 'Thorax, when we draw in our Breath, or even, tho' a Space be made where there was none before, as in a Syringe, by drawing up the Sucker; there are neverthelefs Cafes, in which, if the Matter that otherwife rifes up in the Syringe, has no Expanfive or Elaftical Parts in it, or is not moved or preffed after fome other manser; it will by no means run into the empty Spaces, in orcier to fill the fame: Let any one but caft his Ele upon this little Machine, F H I, (Tab. III.

Fig. 3.) which is commonly to be found in the Shops of thofe that make Air-Pumps, and he will fee, that it an empry Space be made in the Syringe A B, by drawing up the Sucker FA, (after having firit difcharged the Air at $G$, out of the Glafs-Bell A B I, thro' the Air-Pump) the Water in the little Glafs D E, in which the Tube of the Syringe ftands B C, and which is open at C , will by no means rife up into the Tube, nor fill the empty Space in the Syzinge, as ufually; becaufe the Water D E, has no fenfible Elafticity or Spring in itfelf, nor is acted upon, by any other Elaftick Body, which in this Circumftance would be requilite; from whence one may conclude, and not obfcurely neither, what we have already faid concerning Refpiration, viz. That altho' there be space enough prepared in the Breaft, in order for Breathing, yet, in many Cafes no Air (if, like the Water, it fhould happen not to be Elaftick, nor heavy enough) would come in: All which, is yet hereby more evident, that, fo foon as one lets in the Air again into the Glafs Bell, H I B, the fame gravitating upon the Water DE, by its Elaftick Force, immediately caufes it to rife up into the Space that was made for it at A B, thro' the Tube BC, in which, as there is now no Air remaining in it, there is so Refiftance.

He therefore who rightly comprehends all that we have been faying above, and has learn'd from thence how Refpiration is perform'd, muft be convinced after the moft particular manner, that our Brath is properly the Gijt of God; and that it is litewife enjoy'd by Men exactly after the fame manner as the Alms which a Beggar receives from us. For juft as that poor Wretch opens his Hand, and fhows it empty, waiting till the kind Benefactor is pleas'd to put fomething into it, and to Gill its Emptinefs, and remains paifire all the while:

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So all Creatures, even: felf-conccited Man, can oully open their Breaf, and expofe its Emptinefs to the great Giver of Breath; being alfo obliged like the Beggar himfeif to expect, till the adorable Preferver of all things, in ubofe Hand, as the Propher Daniel tells us, is the bieath of Kings, ch. v. ver. 23. vouchfafes to fill the Lungs with bis Air, by the Help of its Elaftick Faculty ; which depends alone on the Power of the Creator, and towards which the mightieft among Men can contribute no:hing at all. It is imponfible to exprefs this in more emphatical and ftronger Terms than St. Paul has done, in the xviiith Chapter of the AIts, ver. 25. He giveth to all, Life and Brenth, and all things. We alfo meet with fomething of the like Nature in Ifaiah, ch. xlii. ver. 5. He that giveth Breath to the People upon the Earth, and Spirit to them that walk therein.

SEct. XI. Convictions from the foregoing Obfervations.

Now let the proud and haughty Creature, called Man, think once feriouny with himfelf, and fee whether he can find any Subterfuge, whereby he may avoid owning, that he is obliged, like the meaneft Beggar, every time he fetches his Breath to reprefent his Poverty to his Maker, and his Inability of preferving his own Life, but one minute; and to beg him, that he would vouchfafe to fill his empty and gaping Lungs and Breaft, with frefh, good and wholfome Air, and fo continue his Life from one inftant to another: And can any Body contemplate with Attention, this Nothingnefs of himfelf, and abfolute Dependance at every Breathing, upon his great Preferver, and the fo many Thoufand, yea Millions of Times, in which this gracious Bencfactor has moft freely granted him

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him Breath, and confequently, his precious Life, during fo many Years; and yet remain, not only ungrateful to him, but even deny all his adorable Attributes and Perfections, even thofe that he has found fo Beneficial to himfelf; and, if it were poffible, winh to annihilate the fame. What thall be faid of fuch unreafonable and impious Opinions, but that they ought to be detefted by all Generous and Grateful Souls?

## SECT. XII. The U.je of Refpiration.

We fhall not here enquire more largely into the Advantage which this Refpiration, (the manner of which we have hitherto treated of) gives to Mankind: Since the moft Learned Naturalifts are not entirely agreed, whether it ferves to cool the Blood; or, whether it be to procure a more convenient Paffage for the Air alone thro' the little Tubes of the Lungs, and thereby to produce a better mixture of Blood; or laftly, to communicate a Nitrous Spirit to the fame in the Lungs; which is believed by many, becaufe, if the Blood running from a Vein, be mixed with Water impregnated with Salt Peter, it changes its dark Colour into a fhining Red, and the Serum or Whey thereof, becomes as clear as Water, tho ${ }^{\text {c }}$ containing neverthelefs, a fufficient quantity of Material Food, as may be obferved by putting fome drops of the Acid Spirit of Nitre, or Aqua fortis therein, which will feparate a White Curd from the faid Whey: Now the Arterial Blood has likewife the fame Property, being dark before it comes into the Lungs: but after having paffed thro' the fame, and therein undergone the Action of the Air (be it what it will) it difcovers a bright red Colour, when difcharged into the Left Ventricle of the Heart, and when it proceeds further into the Arteries : And that which is obferved by fome
fome with greater probability, is, that the Air be ing Nitrous, will change the Blood, that has beer drawn out of a Vein, whilft it ftands expofed in a Bafon, from a dark, to a bright red Colour, giving it a Tincture perfectly like that which it acquires by the mixture of diffolv'd Salt Peter. We fhall pafs by all thefe things, by reafon of the Difputes and Controverfies of Learned Men, leaving them to be difcover'd by the following Ages, and confine our felves only to an Experimental Enquiry; which of the aforefaid Benefits and Advantages, or what other are the true ones that may be affirmed to be communicated by the Air to the Blood.

This is however unqueftionably truc, That the drawing in of the Air is of fo great a Convenience, that no Body could want it long without Dying ; and that our Heart, and the whole Structure of the Veins, are formed after fuch a manner, by the All-wife Creator, that all the Blood of the Body, is made to pals feveral times in an Hour thro' the Iungs, and there fubjected to the Operation of the Air.
SECT. XIII. The Difpufition of the Air in the time of Pefritence.
Now, of how great Importance, befides the Elatical Force and Gravity of the Air, the good Difpofirion and Confitution thereof, is, towards the Prefervation of the Lives of Men, and Beafts, is very plain at thofe Seafons, in which the Air being Corrupted, Peftilential Diftempers are occation'd, and Kings and their Subjects, and Small and Great, are fnatched away by Thoufands: And thefe kinds of Difeáfes muft not be afcrib'd to any. other Caufe, fince, being common to all Sorts of Men, they muft likewife proseed from one common Source or Spring; aiad that can be nothing
elfe but the Air, which is common to all Mankirid. The famous Profeffor Schacht has given us an Acconnt of a dreadful Example of this Peftilential lifection of the Air, in the laft Plague at Leyden, viz. by expofing a Bucket of Water a whole Night to the Air, even within Doors, upon which in the Morning there ftood a kind of a Cream or Scum of divers Colours, that had been communicated to it by the Air; this being gently skimmed of with a Spoon, and given a $\operatorname{Dog}$ to drink, the Poifon was fo Strong, that he died of it in a few Hours: And how pernicious alfo in general, the Corruption of the Air is, will abundantly appear from the Melancholy Experiments whereby it has been often feen, that People have been miferably Suffocated, and Dyed in an Air to which they were accuftomed all their Lives, as foon as that fame Air becomes Infecied, and Poifon'd with the Smoak of glowing Charcole,
SECT. XIV. The Air leaves fomething in the Blood.
Now the Opinion, that the Air being drawn into the Lungs, leares fomething there (whatever it may be) and does not come out again of the fame Temper, feems to be fomewhat probable from certain Experiments, which I have found among my Notes in the Year 1695, by which it fhould appear credible, that the Air leaves behind it in the Lungs the fame Particles which ferve to maintain Flame. Concerning this, the Reader may have recourfe to the Ninth Section of the Twenty firft Contemplation upon Fire where the Experiment is thewn in all its Circumftances. Befides which, there is to be found in the Memoirs of the French Academy of Sciences, Anno 1707. p. 213 .an Obfervation of Monfieur Homberg, where he fays, That if any Body has been in a Place where there was a ferong Scent of Oyl of Turpentine, he will difcover afterwards that

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his Urine has the fane fmell of Violets, as if he had fwallowed Turpentine itfelf. Now fince thefe finc Particles of the Oil of Turpentine do not feem to have enter'd his Body, otherwife than by Refpiration, and it being very probable from the fmell of the Urine, that they mulf liave been firft mingled with the Blood, this Gentleman concludes, that the Air leaves fome Particles behind it in rhe Blood; but we fhall not here expatiate upon thofe things which fome People hold uncertain.

SECT. XV. Convictions from the foregoing olfervations.
Now can any Body, that has well weighed and underfood all thefe things, avoid feeing that his Precious Life is in the Hands of another, and how greatly we are oblig'd to fhew our Gratitude for his Goodnefs, in continuing the fame : His, I fay, who preferves this great Sea of Air, in which Men live like Fifnes, in fuch a Difpofition as to -nake it fit to perform this greatOffice to the whole Race of Mankind, and fo many other Creatures, in preferving their Lives and enabling them to breathe? Or, can the fane likewife be rectified by any Humane Means, alter it is corrupted and become fatal both to Rich and Poor? Now if all this be perform'd by Chance, and without the Providence of a Gracions and Powerful Ruler, how comes it to pafs that fo many thonfand Years, among fuch great Revolutions that it undergoes, by Storms, Thunder and Lightening; from fo many poifonous Vapours exhaling from fubterraneous Caverns, and from rotten and putrified Bodies, none of ' 'em all have hitherto been able to deprive it of that Conftitution, by which it preferves the Lives of all Creatures; fince if every thing be Accidental, aad not undicr the Direction of a wife Being, the one might as eafily come to ties of the Air, an exprefs mention fhall be made in its Place.

In the mean time, let every Body, that has the Knowledge of his Maker and Preferver at Heart, ferioufly recollect all that has been faid about $\mathrm{Re}-$ firation, and, in a filent Retreat, examine himfeif, whether he can maintain with Reafon, that this Air is not created for this very Purpofe among others, in order to preferve the Life of every Creature breathing, fince this alone, and nothing elfe in the World, has the Qualities that are requifite thercto? And let him fay, if he dares, that all that moft amazing Structure of the Mufcles of the Breaft, is formed by meer Chance only, without any Profpect of that great End of Infpiring and Expiring of the Air, fince there is here likewife fuch a great Number of Mufcles difpofed after fo wonderful an Order, to produce that very Effect only, or hardly any other: Can he imagine, that the Lungs were made without Underftanding, and placed in the Breaft after the manner we have already fhewn? Whereas, if they had been difpored any otherwife, all the Properties of the Air, all the Difpofitions of the hundred Mufcles, which now ferve this Work, would be entirely in vain, and the whole Globe of the Earth would be prefently difpeopled. Can any one fancy, that fo many Ribs and Cartilages, of which the Breaft is compofed, fo many Mufcles by which it is moved, together with the Midriff and Lungs, have met one another in fuch a little Space by meer Chance; and that the Air alfo has encompaffed them all without any Purpofe; whereas, if but one of thefe Circumftances were wanting, the great Bufinefs of Refpiration, and therewith the Lives of all Creatures, would immediately be ended? Can any one think, that where fo many and fo different

Things

Things concur to one End, the fame are not madk with this Defign, that they fhall be ufeful to eact other? He would be afham'd to maintain, that a curious Lock and Key adapted to a ftrong Box; and by which alone it could be open'd, was not made by an Ingenious Workman, but by neer Chance, by which only they had met together. Unhappy Men! that can centinue in fuch fenfelefs Opinions, after fo long and daily Contemplations of thofe Works of the Creation, in which the Wif dom of the Creator is to vifibly manifefted.

CONTEMPLATION VIII:

> Of the Structure of the Veins.

## Sect. I. The Tranfition to the Veins.

WHAT has been faid feems to be more than fufficient, not only to bring a Sceptick into the right way, but even alfo to convince the moft obftinate Infidel, that our Bodies muft have been formed by a Wife Creator, and that the Origin thereof can be afcribed to nothing lefs than an $A c^{-}$ cidentaland Ignor ant Caufe; yet, if there fhould ftill be any Body who either thro' want of confidering what has been already faid, finds himelf unmoved, and confequently unconvinced thereby; or
a'tho Who' he has underftood it, fhould yet with-hold nis Conient to the Conclufions that flow from chence ; let him go but one ftep farther with us, and fee whether, without a Contradiction of his own Confcience, he can contemplate the wonderful Structure of the Tubes thro' which the Blood circulates, and which are contriv'd for fo many Purpofes; and then belicve, if he can, that He who formed them all, propofed no End to himfelf, when he made them, nor knew what He himfelf was, nor what he had Created.

## Sect. II. The Courfe of the Arteries.

Now in order to the compleat Conviction of all. fuch Atheifts and Scepticks, they are intreated ferioufly to confider with us, whether it can be imagined, that the Veflel (Tab. II. Fig. 3.) which is called the Aorta, Arteria Magna, or Great Artery, has, without an over-ruling Underftanding or Defign, acquir'd fuch a Form as is fhewn from Verbejen, in Tub. III. Fig. 4. in the particular Scituation wherein it appears in Humane Bodies.

Defides other Wonders which we don't meddle with here, we know, that there is not any one Part of the Body, as yet difcover'd, in which we find that the Blood is not convey'd thither by the Branches of this great Artery, either for Nourifhment or Motion, and likewife for the Separation of other Humours and farther Ufes. Will any Body therefore believe, that this whole Difpofition of the Arteries, has been thus contrived by Accidental or Ignorant Caufes?

Now in order to impart fome rough Conception or Idea hercof, which might otherwife appear a little obfcure to thofe that are unexperienced; let us here reprefent to ourfelves the Beginning A O of this Artery, as cut off from the Heart at O,
and we fhall fee two little Arteries $a$ a, called tha Coronary Arteries, coming out of the fame, ank turning towards the Heart; the fame are repre fented a little bigger in Tub. II. F.g. i i B B.

Then if you afcend as it were ftreight forwards, you may fee in Tab. III. Fig. 4. the Carotides 66 , proceeding out of this Veffiel, the Palfe of which a Man may feel with his Finger on each Side of his Wind-Pipe; thefe having, as they go on, communicated fome Branches to the Wind-Pipe and Parts adjacent, do each divide themfelves into two Branches, one of which, ee, goes into the Head, to the thick Membranes of the Brain, to the Mucilaginous Glands, to the Eyes, to the inmof Parts of the Ear, and to the Subftance of the Brain itfelf; and t'other Branch, $d d$, proceeds to thofe Parts that compofe the outfide of the Head, and is the fame which is felt in the Temples of the Head.

We may obferve farther, that this great Artery begins to bend itfelf at A, in order to defcend on the left Side; that on either Side there appear two great Branches D and L, called the Subclavia; which, as at F , are again divided into two great Branches, one of which feems to terminate at the Elbow, and the other, E, carries the Blood to the remaining Part of the Arm, and the whole Hand, quite down to the Fingers: But before this Divifion at F, the Subclavia fends out feveral Branches; fuch as the Branch $m$ downwards to the Breaf, and $n$, whofe lateral Branches become the fuperior Intercoftales; there go farther upwards the Cervicales cc, otherwife called the Vertebrales, whofe lateral Branches at $i$ i difcharge their Blood into another common Veffel $h$, which like a Chain runs along the Back-Bone downwards. Finally, thefe Vertebrales goes to the Brain. To fay nothing more at prefent of all the little Bran-
ches, as $k$, which go to the Mufcles of the Neck, - $p$, to the Shoulder-Blade within and without, ind all thofe which we may obferve to proceed rom the Arteries of the Arm.

The great Artery turning itfelf now downwards it $B$ and $C$, produces firft the Bronchialis $b b$, which eems to feed the Lungs; this is followed by the nferior Intercoftales cc, which come out here acrofs, ind are off; and under thefe there comes forth ometimes a Branch to the Midriff $d$, under which s the Caliacale, which divides itfelf into two Bran:hes, the Right of which goes to the Stomach, o the Cawl or Omentum, to the Pancreas, to the Jall-Bladder, and invefting Membrane of the -iver; and the left, after having communicated oine little Branches to the Stomach, Cawl, and ancreas, terminates chiefly in the Spleen.

Under this Caliaca, the uppermof Mefaraica n, omes out of the Great Artery, and runs thro ${ }^{3}$ he Midriff ro the thin Inteftines, in the fame manler as the Artery $u$ does to the thick ones.
ss Are thofe that go to the Kidneys and to the -oins; vv are the Spermatic Arteries.

After all thefe Branches, the whole Great Arery divides itfelf at $w$ into two great Branches, :alled the Rami Ilirci, which fending their Branhes to the lowermoft Bowels of the Belly, as the 3ladder, the Matrix, and other Parts of Generaion, to the linteftinum Kectum, © ©c. proceed farther on both Sides down to the Legs, and to the exreme Parts of the Toes, after the fame manner is the Vena Subclavia at $\mathbf{F}$ does to the Arms.

## Sect. III. The Courfe of the Veins.

Now as this great Artery tranfmits its Branshes to all the Parts of the Body, can any one magine, that not one of them, how little foever, Vol. I. H
is to be found, to which there is not again a Veit branch adapted? Which Branch carries that Bloo back to the Heart, that was brought from thenc by the Artery, to all the other Parts.

Let thofe who defire to form any Notion heie of, caft their Eyes upon Tab. III. Fig. 5. and ove ferve how thefe Veins run along the Body and after having performed their Office, carry th Blood bach to the Heart: So that the fame Bioo which in Fig. 4. (to give one or two Inftances thiche of) was brought from the Heart thro' the Arter Subclavia D, to the Extremities of the Finger $7,8,9$, is again received by fmall Branches of th Vein A N, in Fig. 5. by which it returns thre QOMG, and is brought thro' a great Veffel E called the Vena Subclavia to the Vena Cava C, ant fo on till it difcharges it lelf again thro' the Orific A into the Heart.

Thus we here fee the Jugular Veins, Fig. 5.d a $e e$, and the Vertebrals $f f$, bringing back th fame Blood, which in Fig. 4. was carried into th Head, and other Parts, thro' the Arteries $b b, a$ and as before, Fig. s. leading it to the Heart A thro' the fame Vena Cava C.

We muft fuppofe after the like manner, that thi Blood, which was carried down thro' the Arter: T, (Fig. 4.) and, as in the Arm, driven to the Ex tremities of the Toes, is there received firft of al in the fmall Veins, in order to bring it back, anc farther thro' the Vein I G, Fig. 5. along E B (which is called, Vena Cava Afcendens, becaufe th Blood pafies thro' it upwards) and difcharge itfelf in the Heart at A.

## SECT. IV. Convictions from both the forezerits Seczions.

Now fuppofing the fane Phenomena in all the Viens and Arteries; can any one imagine, that his great Attcry, and the whole Structure of he Veins, are made without Knowledge and Jnderftandirg ? or thateach of them are not thus ontriv'd for their particular Purpofes, of carrying he Blood backwards and forwards? He that will enture to maintain this, how can he be convined? And let him but ask himfelf, if fceing the 'pes and Aqueducts of a Fountain (in which there not the thoufandth part of fo much Skill or Art as in the Duets of the Blood) he will dare to mainain, that he really believed they were all ifpofed after fuch a manner, without any Wifom, or Defign, or Contrivance of the Mafter ; nd that if he flould fay fo, whether he were like 0 find any Credit wit! People of good Senfe or Reafon?

ECT. V. A rough Reprefentation of the Circulation of the Blood.

To the end, that an unexperienced Perfon may; n fome meafure, comprehend what has been faid bove, and have fome Idea of the Circulation of the 3lood, let him fuppofe, that in Tab. II. Fig. 3. the [ubes or Veins E and F, are the fame as are rerefented in Tab. III. Fig. 5 by C and B; from which he Blood paffes upwards and downwards into the Light Ventricle of the Heart, and thence thro' he Veffel G (Tab. II. Fig. 3.) into the Lungs, and hence again thro' another Vein H, into the Left Ventricle of the Heart, whichtwo Veffiels H and $\mathcal{J}$, are fhewn before, in Tab. II. Fig. I2 by C E and

B E, which encompals between them both one o the Branches of the Lungs A E: Laftly, let hin fuppofe that the Blood is protruded from this Lefi Ventricle, by the Contraction or $S_{y} /$ oole of the Heart into the great Artery I (Jab.II Fig. 3.) which, how it diftribules itfelf by its Branches, has been latel! fhewn in Tab. III. Fig. 4.

So that by this means the way of the fo famou Circulation of the Biood may appear to any on that confiders the fame ; which Blood paffing from the Heart thro' the Arteries, to all the Patts o the Body, is tranfmitted back by the Veins intec the fame, and then having pass'd thro' the Lung between both the Ventricles of the Heart, refume the fame Courfe again thro' the Great Artery.

He that hasererfeen the Ciiculation of the Bloos in the Tail of an Eel, by the lielp of a Microfcope will be very well fatisfied concerning this Motion without our producing any farther Proofs thereof tho' they are very numerous; and he will be no lef? convinc'd of the great Velocity, or Swiftnefs, of thes B'ood's Motion, if ever he faw it fpringing out of a cut or wounded Artery.

S E C T. VI. Howi often the Blood circulates in an Hour
Now that we may farther enquire how often the Blood circulates throughout the Body of a Man in the fpace of one Day, let us agree with the Great Hurvey in the following Pofitions.

1. That the Left Ventricle of the Heart may contain about two Ounces of Biood; tho' the ac curate Dr. Lower has often found it larger.
2. That in each Contraction of the Heart, thil Caviey is in a manner quite empty; and therefore two Ounces of Blood are at each time protruded into the Great Artery, which fivelling up therewith caufes the Pulfe.
3. Ifwe now fuppofe, that each Pulfe is made in a Second of an Hour, or in the both part of a Mirute, which every one may obferve in himfelf, Ind is at prefent, for Conveniency fake, allowed by many, this will produce 3600 Pulfes every Hour ; and coifequently twice as many, that is, 7100 Ounces will pafs through the Heart in the pace of an Hour.
4. This together will malie the quantity of 600 Mounds of Blood (allowirg with the Phyficians 12 Ounces to the Pound) that will pais thro' the Heart in an Hour.
5. Now it is the common Opinion of the Anatomifts, that a Mat has feldem more Blood in his Eody than 24 fucin Pounds, or lefs than 15; but Fypofing here, with Lcwer, that the fame amounts to 25 fuch lounds, it is piain, that the whole Blood palfies thio' the Heart $2+$ times in an Hour, that is to Cay, 576 times in a Day and a Night.

Now if we hoould maintain with Dr. Lifter, that there are 75 Puifes in a Minute, or 4500 in an Hour; and that the bate Blood only, which circulates thro' the Heart, without including other Humours, as the Gail, Spittic, efc. which are ferarated flom it, and do not circulate with it, confits of no more than 7 Pounds, as is pretunded by fome, the fame will pafs thro' the Heart at leaft so Times every Hour, if he allows 16 Otinces io the Polind ; ard abore ron, if but is Ounces; but let the Difference be what it will, it is cirtain it goes thro' it a grcat many times.

Sict. VII. Corvitions fromi the foregoing Obferiatich.
I er now an urhappy Atbeift fit down by himFeif, and fix his Thoughts upon the furprizing Switnef of the Blood's Motion; let him confider how great the Sirengih of the Heart and Arterics

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muft be, which, during the whole fpace of his Life, produce fuch a fwitt Stream of Blood; let him reprefent to himfelf the various Pofition of fach numberlefs fmall Branches of the Veins and Arteries thro' which it flows, and having reflected upon the Misfortunes that happen to a Man, in cafe this Circulation is ftopp'd even in the vers finalleft Branches, and particularly, that ail this :s bought about in his Body, without any Power of his own Will, and even without knowng or being fenfible of what paffes: Let him ask hinimelf, whether he can, with a confenting Concience, maintain, that this whole Stricture of the Heart, Lumgs, Veins and Arteries, was not prodtuced by a Wife Mafter; and whether this Biood can bo carried about fo many thoufand Times, for the fpace of $40,50,60$, or more Years, through fuch natrow Veffels, and never ceafe moving, cinlefy ir be by the Direction of a Powerful and Giracious Ruier, who preferves and fupports his Life, without the Afiftance of any concurring Creature.

Sect. VIlI. Several Particulars. I. Orifices of the Lateral Branibes.

That wemay not betoo tedious here, we fhall pals by innumerabie Particulars, which might prove a Powerful, Wife, and Gracious God, even to the blindeft of Men; and only himt at a few, for the further Conviction of thofe deplorable PhiIofophers.

Diffeet a Vein of an Artery, length-wife, and obferve how regularly the Orifices in both of 'em lye; thro' which, from the latter, the Blood paftes into the Branches that Spring out of it, and from the former is receive dinto the Vein out of the Branches thereof.


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SE ct. IX. 2. The Arteries grow Narrower.
Can it be imagined efpecially, that it comes to fuis by Accident, that the Arteries are larger next the Heart, and gradually narrower, and diviiled into numerous little Branches, as they go farther from it? The reafon of which is, to prevent tlec B ood, which iffues with fo much Violence out of the Heart, from pafing by the Lateral Branchos and following its way only in the large Veffeis; for if that fhonld happen, the Parts which lye on the. Sides, would not be fufficiently provided with their Shate of the Nourining Blocd, and fo would withei or perifh: For it only comes to pafs, by this narrowing of the Arteries, that the Blood flowing firom the Heart, pufhes forwards all that it finds in the Artery, to make place for it felf; but that not being able to pafs fo nimbly becaufe of the Straitnefs of the extreme Branches, it preffes ciety way upon the Sides of the Artery, and expanding the fame (which is the Caufe of the Pulfe) sufhes into the Lateral or Side-Branches with more force than if the Aitery had been every where of equal Bigncfs, or of greater than it had at its Beginning.

And muit not every Body confefs, that he can, as it were, fee! with his Hands our Great Creator's End and Defign in thefe-Orifices that are found in the Anteries, ald out of which the Side-Branclees fpring, if he has ever feen the Obfervations of that exact Anatomin Lureer, in Tib. III. Fig. 6. whicre at obcd, the Great Artery coming out of the Heat at $c$, and the Branches fpringing out thereof, $a$ a $a$, making the Cervicales and the Aiteria Jubchivia, are repefented. Now if the Blood were proiruded from 0 , through $l$, and $c$, to $d$, it would pafs by thele Buanches, by reafon of the quifite; for which reafon the Great Creator has placed fuch Protuberances at $c$, on the Side of the Orifice, as may in fome meafure ftop the Paffage of the Blood in its way from 0 , thro ${ }^{3} c$, to $d$, and caufe it to turn its Courfe into thele Branches. Can any one here likewife deny a Defign, and think that all this comes to pafs by Chance? Why then does not the fame Phanomenon occur in all other Branches, tho' not wanted there?

## Sect. X. 3. The Arteries contract themfelves.

But altho' the Blood that comes out of the Heart, does require a fufficient Swiftnèfs by the Contraction thereof, yet there feemed to be Danger that the Heart expanding itfelf, in order to receive New Blood, two great Evils might happen, viz. Firft, That the Blood might by its Weight fall back intothe Heart; and Secondly; that the contractive Faculty of the Heart ceafing, the Circulation of the Blood mightlikewife be ftopped

How the former is prevented by Valves, has been already fhewn, when we treated of that Matter ; and as to the latter, can any one imagine that it happens by Chance and without Defign, that in thie Arteries themfelves, where they have any Largenefs, the Membranes of which they are made up (much like what has been faid about the Throat) have, befides the Tunic A, (Tab III. Fig. 7.) thro' which the Blood-Vefiels for the Nourinment of the Artery, and the Nerves particularly run, and B , where there are many little Glands, ftill another Tunic C, which confifts of feveral Amnular Fibres lying upon one another; and under thefe the Fourth, D, which is Membranous, and provided with long Fibres running ftreight forwards. which are thicker, and more flefhy near the Heart.

Now when the Artery is fitled by the Blood that omes out of the Heart, to the end that the Cirsulation fhould not be obftructed, thefe Ammular Elefniy Fibres contract themfelves, and fo make the Artery narrower on all Sides; by which means the Blood being prevented from going back to the Heart, is forced to proceed forwards and fideways, and thus the Circulation of the Blood is ineflantly continued, even while the Heart is open, and cannot protrude it.

Does not all this Apparatus of Inftruments, which compofe the Arteries, difcover that they muft have been formed by an underftanding Artificer, who has adapted them all to wife Ends and Purpofes?

> SECT. XI. 4. The Pulfe is not felt.

Besides all this, forafmuch as thefe Arteries fercad themfelves thro' our whole Body, and at every time upon cach Contraction of the Heart are expanded with fo great a Force, and do Day and Night occafion fo ftrong a Beating as we find by the Pulfes, who can conceive the Reafon why we are not fenible of it as long as we are in Health, notwithfanding that we may find them beat fo. ftrongly in many Places, if we do but lay our Finger upon them ?
'Tis true, that fome lay it down for a Maxim; De confuetis non judicat Anima; that is, Our Mind dies not judge of that which we are ufed to do. But if this were true, wc fhould judge as little of our Refpiration as cf our Pulfe, being accuftomed as much to the one as to the other; and yet we find, . tho' we often breathe without thinking of it, that with never fo little Attention we can perceive the Motion of the Air in our Mouth, Noftrils, WindPipe, and Lungs, and difcover from the Action it felf that we breathe; whereas, on the contrary, let
a Man that is in good Health attend with a: much Care as he can to the Beating of his Hean and Pulfes of his Arteries, he fhall not perceiv them in the leaft.

Does there not then appear, in a very particulat manner, the Wifdom and Goodnefs of our Great Cteator in this matter likewife, who, that the Attention which we ol:ght to allow to other things, might not be difturbed by this continual Pulfation, has been pleafed to render us infenfible of it? And tho' an Atheift cannor, or will not, fee this, yet whoever ackiowledges a God, may learn from thence, that it is his Duty to fix his Thoughts upon his Maker and his Works, who has fo graciouny wrought this Wonder in him, to the end that his Attention frould not be drawn away by this continual Beating of the Arteries.

Nor can any afcribe this to any material Property of the Arteries themfelves, forafmuch as cvery body is but too fenfible, to his own Damage, of all thefe Beatings, when in a Fever, or other Diftempers, the Fibres are extended by the Blood more ftrongly than ufual. The fame may be obferred particularly, when in great Diforders and Frights the Annular Fibres are contracted more narrowly, and after a cramping manner, than they ought to be, by the irregular Motions of the $\mathrm{Hu}^{-}$ mours of the Nerves which move the Arteries; fo that thefe Veffels being become ftreighter, the Violence which they fliffer from the Blood ifluing out of the Heart, is more fenfible than ufual. This is known to them that have heard the Complaints of fome Women, who (as it is faid) being fubject to fudden Difordersupontheleaft Accident, do many times feel their. Arterics beat throughout their whole Body.

I don'r know whecher it may be ufeful to add here, that the Contracion of the Arterses, and orher Parts of our Lody, won the Account of

Frights, feems in fome Meafure to be confirmed, becaufe in fuch great and Heart-affecting Motions, the whole Body is often put into a cold Sweat, which is known to proceed from the Contraction of the Glands in the Skin, that are thereby forced to protruce their Moifure ; and if there be any fmall Hairs planted in thefe little Glands, they will rife up an end by the Contraction of the fame; which Phanomenon People may have often obferved upon a Fright, not only in themfelves, but in Bealts too.

SECT. XII. 5. The Concurrence or Conjuntion of the Veins.

If it be not owing to the Wifdom of the Creator, that there is tio Part in the whole Body to which the Biood does not extend itfelf, and from whence it hikew fe returns; Low comes it to pafs, that Arteries meet Arteries, and Veins meet Veins fo frequently, and difcharge their Blood into each other, to the end that if any of 'em all flould be difabled by Amputation, $\mathrm{Ob}-$ Atwétions, or otherwife, the Blood might pafs another Way to or from the fame Place?
$\mathrm{S}_{\mathrm{L}} \mathrm{ct}$. XIII. 6. The Divifion of the Arteries into Capillary Tubes.

T w o Things more may be obferved, tonching the Circtilation of the B.ood thro its Veffels; in which, mo lefs than in the foregoing, the Wifdom of our Adorable Creator fhines out as clear as the Sun at Noon-Day.

The firft is, that from the ftrong and fwift Motion of the Blood in fuch Arteries as are large, there feems to be a Danger, that by reafon thereof the Blood cannot contribute any thing towards

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the Nourifhment of the Veffels themfelves thre which it runs fo faft. Can one confider then with out Amazement, that, to obviate this Inconveni ence, the Arteries are divided in thofe Place where this Function is required, into an unfpeal able Number of fine and narrow Tubes, whicl the Anatomifts, by reafon of their Smallnefs, an wont to call Vafa Capillaria, or Vafa Minima; tha is to fay, Veffels that are as fmall as a Hair, anc fo little, that they cannot therefore be defcribe among the Arteries in Tab. III. Fig. 4. and all thi to the end, that by paffing thro' thefe Defile's o By-ways, and ficking to the Sides of fuch narrow Veffels, the Blood might proceed more flowly where it is neceflary that it fhould do fo, whilif that which paffes thro' Veflels fomething wider may purfue its Courfe to the Veins with greatel Swiftnefs.

SECT. XIV. 6. The Narrownefs of the Tubes leffern the Scuij'tness of the Blood.

Now that a fluid Body protruded with the fame Strength, rans more flowly through narrow than wide Pipes, for the above-mention'd Reafons, is weil known to all Fountain-Makers, who can make the Pipes, through which the Water is to pars, fo narrow, that by the ficking of the Parts of the Water to the Sides thereof, the Stream flall not rife mar fo high as it would do thro' larget Pipes: And if any Body doubts this, he may have ain ocular Demontration of it, by the following very catie Experment.

Let him take the Glafs Tubes E F G, of difierent Bores ('Tib. IV. Fig. I.) of thofe we made Ufe of (as I find it upon my Notes) one of 'un 1E, was a narrow Neck of a broken Thermomete: the Ssond F, was fomething larger, and about
he fize of the Tube of a Barometer, or the Quill If a Pen; the Third $G$, was fo large that one night thruft one's Finger into it. Then let him ye a little Thread about each of ' em at $\mathrm{H}, \mathrm{K}, \mathrm{M}$, o that their Parts HI, KL, MN, may as near is poffible be of equal length; and putting them nto a long Glafs, A B C D, which is filled with Water up to A B , let their lower Ends, I L N, each almoft, but not quite to the bottom D C, nfuch manner, that the Threads H K M, may Je even with the upper Striface of the Water: Then if he ftops thefe Tubes with his Finger, at EF G, and thrults them (being empty, or rather full of Air) one by one, perpendicularly down into the Warer, and fuddenly remove his Finger from the Orifice, he will fee the Water in the narroweft Tube E, rife up even with, yea, rifibly above the Superficies of the External Water H : Whereas in the Tube F, the Water will rife up as bigh as $O$, and in the Tube $G$, yet bigher to P. Now thofe that are skill'd in $H y$ droftaticks know, that equal Parts of Water lying in the horizontal Superficies QR, which paffes under the Orifices of the three Tubes IL N, are preffed upwards with equal Force; and therefore, that the leffer Force, which appears in the afcent of the Water in the narroweft Tubes, muft only be afcrib'd to the greater Narrownefs thereof.

Now whether the Curvity of Angles, made by thefe little Branches of the Arteries; as alfo, whether their Multiplicity (fo that being taken together, they may by reafon of their Numbers, have more Widenefs than the great Artery alone) do contribute any thing towards the flower Motion of the Blood, we fhall not enquire farther here.

## SECT. XV. 7. The Ve.ns grow wider.

The Second thing is, That in cafe the Blood, which thro' larger Vefiels runs fwiftly along the Arteries, fhould retain the fame Swiftrefs in the Veins, by which it is carried back again into the Heart, there would be Danger that the Heart fhould be overwhelm'd with too much Blood, and the Right Ventricle of it filled fo full, that it could not be able fufficiently to exert its contractive Faculty.

Now to prevent fuch pernicious Swiftnefs, could any body have thought of a wifer Expedient, than to have made thefe Veins larger and larger, as the Blood came nearer from the extreme Parts to the Heart, as may be feen in Tab. III. Fig. 5. quite contrary to the Arteries, which in Tab. III. Fig. 4. grow continually fmaller from the Heart to the Extreme Parts.

Now that a Liquor paffing thro' a narrow Veffel into a wider, tuns flower in the fame Space of Time, is obvious enough to every one, without proving it experimentally; but if he has a Mind to fee it that way likewife, let him fill a Pipe with Water, and thruft it with its Orifice downwards, into a Bucket, which has likewife Water in ic to a certain Heighth, and forcing the Water as faft as he can out of the faid Pipe, he will find that the Water in the Bucket will afeend but to a very fmall Heighth, tho' all that was in the Pipe came out of its full Length at the fame time; from whence it appears, that the Water in the narrow Pipe moved more fwiftly than that which was in the wider Vefficl: But this is fo plain, that we need fay no more of it.

## SECT. XVI. 8. The little Valves in the Veins.

B U T fitce the Blood moving more flowly in hi.fe Veins ('ab. III. Fig. s.) might, by reaton of its Weight, (efpeciatiy in thofe that carry it disectly upwards) endearour to fink down or go hack, and fo in long Tubes forcibly refift this hower Motion; may we not again difcover here the Providence of the Creator, exerting itfelf in fo peculiar a manner, who has thought fit to place ittle Valves in thefe Veins; fometimes but one, as in Tab. IV. Fig. 2. at A ; fometimes two together, as at B B, whofe Office is to fop the Blood when it attempts to go back, and that it may not, by its Weight, prefs toa much upon that which follows, and thereby retard its Motion?

Now, is all this done by Chance, and without Defign? Why then aie thefe Valves fixed in the Veins, where they are fo ferviceable, and not in the Arteries, where they are fo far from being ucceffary, that they wouta be prejuciicial?

Sect. XVII. 9. Of the Fibres in the Veins and Arterizs.

We muft add one thing more, and fo conclude thefe Remarks, which would otherwife, as is well known to thofe that underfand it, fwell to a much greater Bulk: Can any Rational Man then perfwade himfelf, that the Great Creator had no End at all, or that it come to pafs mercly by Chance, that in the Arteries, where the Blood ftood in need of more Strength, in order to infinuate itfelf into the narrow Paffes of their extreme Branches, the mufcular Fibres, by which they are contracted, are very frong in thole Parts; and on the contrary, in the Veins, which contintally grow larger, and
in which too great a Swifterefs and Conernation would be hurtful, the Fibres are far from being fo ftrong or fo numerous? But that which th Wife Creator caufes us to feel as it were, witl the Hand, is, that in the Vena Porta, the like Fi bres are again ftronger than in other Veins, tho fewer than in the Artaries; thofe being the only Veins of all thofe of the Body, whofe Branches: entering into the Liver, grow narrower and narrower; for which Reafon they require more Strength than other Veins; to the end, that like the Arteries, they may force the Blood to pafs or to the narrow Ramifications, and to the Glands of the Liver.

Now if any one has confider'd and underfood what has been juft now faid, and particularly that about the Structure of the Veins, can he poffibly doubt any longer whether his Body was framed with Wifdom? And does it not follow plainly enough from hence only, that nothing elfe is neceffary towards a Conviction that there is a God, (provided he himfelf vouchfafes to blefs the Means) than to enquire into his Works, even into the fmalleft Fibres? And the neglecting or defpifing fuch Enquiries has been the undoubted Caufe that fo many People walk in Darknefs, in the midtt of the bright Rays of God's Wifdom. I know very well that infolent Atheifts will think all there $\mathrm{Ob}^{-}$ fervations and Reflections to be of little Moment, and much below their lofty Speculations, as being fo obvious even to thofe that are juft enter'd upon the Study of Phyfick: But I know likewife, that as contemptible as they may appear to thofe conceited Men, it is impoffible for them to believe, much lefs to prove, that all thefe Parts were form'd by Chance.

Sect.

## SECT. XVIII. The Ufes of the Blood in general.

Now to pafs by other Particulars concerning the Blood and Veins, of which we have already treated very fully, the Thread of our Difcourfe feems to lead us to the Ufes and Motions of this Blood.

There are Three particularly, that, among thers, are known to depend either wholly, or in art, upon the Blood: The Firft, is the Separaioin of fo many different Humours, which are eiher neceffary to the Body, or muft otherwife be ifcharged. Secondly, the Nourifhment of the Boj. Thirdly, the Motion of the Mufeles.

Now whilft we are going to treat of the firft of hefe in its order, let no Body think that we degn to enumerate the various Opinions of many arned Men thereupon; being contented to fhew he external Difpofition of fome, fo far as it is nown, fince Men have not yet been able to pe ${ }^{\Delta}$ letrate all that belongs to it, befides, it was oth out of our Power and Defign too, to handle is Marter alone in this Place. A rough and geral Account of the Ufes of thefe feparated $\mathrm{Hu}^{-}$ ours will be more than fufficient for our Purg ofe, hich was to convince a fceptical Mind, that we e formed by a God abounding with Wifdom id Goodnefs.
And can any one fill aferibe to ignorant Cauis, which don't even know how, or whether they ork at all, that the Blood, and all the nutritious ices are impecuoufly hurried along fuch wonderVefiels, as has been fhown above, thro' the trole Body, in order to furnifh Matter for the fo z ceffary Separation of fuch a valt Number of diffe(1t Liquors ?

## SECT. XIX. The Enumeration ! Several H.umours.

No w to pafs over the Limpha, which is feparated in fo many Paces, the Gall in the Liver, the Juices in the Puctaas, and in numberlefs other Glands, the Humours in the Stomach and Inteftines, in the Eyes, Nofe, Ears, Mouth and other Parts; forafinuch às there are fill difficent Opinions about them and their chiefeft Ufes: Can one tee that there is difcharged from the Brain fo powerfuland fpirituous a Humour, which is derived by the Nerves to all the Parts of the Body, rendering fomany and furh impoitant Services, and being particularly the chiefuft Caufe of all our Motions; that there exhales from the Pores of the Skin, and by Refpiration, an invifible and continual Vapous (fuppofing a Man to be in good Health) in fo vaff a Quantity, that the accurate Sanctorius has dif. covered, that this alone does exceed every Day all the other grofler and vifible Evacuations?

Can any Body believe, that it happens without a fix'd Purpofe of our great Preferver, in order to continue upon the Earth the Race of Mankind in their Chi'dren, that the Materia Seminalis, for the Procreation of them, is feparated from the Blood, and that the Milk flows from the Breafts of the Fe ma'cs for the Nourifhment of there tender Sucklings? Can any Body contemplate the Difpofition! of the Water-Courfes, when the Blood is feparatec from its Salts in the Kidneys, without difcovering the Finger of his adorabie Creator in alt thefe Things?

Sect. IX. Thbe Pafluge of the Urive.
And to the end, that all that has been here faic may not pafs for Declamation, or Rhetorical Fi:

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gures, let us examine a little more clofely the Difpolitions that are made in the folid Parts of the Body, for thefe three laft mention'd Humours ; without enquiring into that great and wonderful My? ftery, how each of them has acquired its peculiar Faculty or Property, which hitherto remains among the Secrets of the great Creator.

Now to give fome Notion thereof to an unexperienced Perfon, let him fuppofe, in Tab.IV. Fig. 3. that the Blood defcends from D to $u$, thro' the great Artery $\mathbf{D} u$, of the Heart; and becaufe the faid Artery at $u$, and in the farther proceeding Branches, grows continually narrower, that the faid Blood is forced to pafs into the Side Branches; by which means it takes its Courfe thro' one of them, $F$, to the Kidney B, where having difcharged its Salts, it returns by the Kidney Vein W, and o proceeds by C, along the Vena Caiva upwards; igain to the Heart.

In this Kidney (the internal Structure of which s reprefented (Tab. IV. Fig. 4.) the Humour of vhich the Urine is compofed, feems to be feparaed in the outmof Glandulous Subftance, A A: Do we not here, without going any farther, pereive the wonderful Operation of the Defigns of he adorable Creator, who makes this Humour lefcend thro' fuch narrow Veffels B B, which beng collected into a kind of little Nipples, called ,y the Anatomifts Carrinculs Papillares," do filtrate his watry Matter with its Salts into larger Memranous Veffels, cic; which do again difcharge what they had received, for the moft part, intotwo reat Spaces, out of which there is made one reat one, C, calléd the Pelvis; thro' the Orifice hereof this Liquor defcends farther into the Tube ), or the Ureter, which being joyned to the Pelvis; oreprefent a compleat Funnel with its Pipe, which cinginferted at X Y, (Tab, IV. Fig. 3.) in the BladI
der H , makes on each fide a Veffel G Y, in orde to difcharge that which is brought into it?

Two things feem to be requifite here; Frrft that the Urine coming in o the Bladder, may $b$ driven olit again; and, Secondly, that in orde to prevent Inconveniencies, ic fhould not happe continua!ly, not without our Will. Now can it b imagined, that it is without Knowledge and Do fign, that there fhould be Mufcles likewife place in the B adder, in order to contract it, and fore out the Water, befides the Mufcies of the Bell which coald have preffed it; and particularly, tha tho' the Bladder were contracted and drawn toge ther, that which is contained might have burft ot at every Oritice, if it had not becn fo contrive that that Humour fhould not be able to return thr the Oritice Y Y, by which it defcended from th Ureters G, but only thro' that Paflage which NatuI has preferbed it?

Thus we fee that it is eafie to blow up th Bladder H, by one of its Uieters GY, but if fhould be blown by that Tube, thro' which th Urine comes out, the very Children know, th. the Wind cannot pais that way thro' the Orifice of the Uieters.

And as for what relates to the fecond Thing, y may obferve, that the Bladder is fortified with ftrong Mafealar Valve at the lower cnd of it, prevent the Leaking of its Humorir, and is fh up by the fame till a greater Force obliges it give way, and fuffir the Water to pafs thro' it.

Add thercto, that bicaufe this Hemour is a moft always Salt, and ofeen fharp, the moft gr cious Care of our Creator (to the end, that Ghould not cocrode the innermoft Membrane of t Pladder, which is exceeding fenfible, and fo oce fion Pain) has fortified the fame with a kuado toigh and flimy Noiflure againt it in the infors

## Sect. XXI. The Breafts of Women.

T ie fame Wifdom appears in the adapting other Things to their Ends, fuch as the Tubes of the Duturs Salivales, and efpecially in the Structure of thofe Ducts, by which the Gall paffes from its Bladder, and from the Liver to the Inteftines; and the Veffels of other Parts, where the Humours are feparated from the Blood.

But can he, who fees no more than the little Glands A A, in the Breaft of a Woman (Tab. IV. Fig. 5.) (the external Tegunent being taken off) in which the Milk is feparated from the Blood; and the little Tubes 66 , into which it flows, and where it is preferved, to the end, that it may in proper time be fuck'd out thro' the Nipple C, where they are open, and in which they terminate: I fay, can he that fees thefe Things imagine, that this only Part, to deduce no Arguments from all the reft, had not a Maker, who deftined it to perform a Service fo very important to all Creatures in their moft tender Age?

SEct. XXII. The Stiruture of the Seminal Veffels.
Now that every one may be yet farther consinced, that all the Parts of our Body are with great Wifdom adapted to particular and certain Ufes; let us go on, and confider the other Parts reprefented in Tab. IV. Fig. 3.
I. How the fpermatic Arteries P P, coming on each fide out of the great. Artery $D_{u}$, do defcend to the Tefticles, therein to difcharge the feminal Matter which they bring thither with the Blood the Remainder of which is carried back again from the Tefticles to the Heart by two Veins O and $n$, and with how many Windings and Turnings
the fame afcend, may be feen on the left Side 00 , where they are reprefented as ftretcht out ; whilift the Artery P, defcends ftreight forwards in a Man, as Verheyen has oblerv'd.

And, that we may all fee that the Wifdom of our Creator extends itfelf to the meaneft Things, it need only be cbferv'd, that the Arteries P P, do, for the moft part, proceed immediately from the great Artery $\mathbf{D} u$, ; but that the Veins $\mathbf{O}$ and $n$, thereto belonging, do not both, but only one of ' em , viz. O , and on the Right, difcharge itfelf into the Venia Cava $\mathrm{C} u$, whilft the Left $n$, is inferted into the Kidney Vein W, becaufe it was to be feared, that as it took its way into the Vena Cava C .4 , the courfe of its Blood might be obftrutted at every fwelling of the Artery, by reafon of the continual Puife of the great Artery, over which this Vein muft have neceffarily pafs'd, as appears by the Figure ; fo that by this Conveyance of the Blood, from $n$ to W, and from W to C, (which otherwife, if it ran as at O would be fhorter) this Inconvenience is prevented by a careful Providence, and it is fully prov'd, that it intervenes in fo fmall a Matter as the Courfe of this Vein.
2. That in order to bring the feminal Matter, feparated from the Blood in the Tefticles, to its deftin'd Place, two Tubes, R R, or the Vafa Deferentia, afcend from the faid Tefticles, and carry the Seed into the Veficula Seminales, which appear on one Side behind the Bladder X X, and there it is preferv'd till the time of its Ufe.
$3:$ That the End of thefe Seed-Veffels is ftop'd by little Glands, which prevent the Matter from diftilling out of its own accord, and yet do not obftruct the fame when an Ejection is neceffary.
4. That in each of the Groins there is a peculiar Tube made for that purpofe, of the Membrance that lines the Be!!y, call'd the Peritonaum, thro' which
which the feminal Veffels or Vafa deferentia R R, afcend; as may be feen Tab. II. Fig. I. W W.

And particularly, to prevent the Inteftines from preffing into the Scrotum or Cod, and caufing what we commonly call a Burften or Broken-Belly, thefe Tubes are cover'd with a Membrance in Men; but in Dogs, and other Creatures, whofe Pofture is not erect, and confequently which are in no danger of tuch Accidents, the fame Tubes have no Coverings but are quite Open.

SEct. XXIII. Convictions from the foregoing Obfervations.
There are whole Volumes written to fhew all the Particulars of rhere Parts only; we fhall therefore go no further, but leave it to every one hat reads and underftands what has been already aid, to examine himfelf, whether he can believe, that in all thefe Matters about the Seed, Bladder, Bieafts, \&cc. the Wifdom of a Creator has had no Room; and whether he can admit, that among thoufands of Differences, any one of which, in cafe all things had been produced by Chance, and without Underftanding, might have here equally some to pafs, thefe only flould have taken effect; all of which are fo well adapted to fuch great and neceffary Purpofes? I can't forbear faying one word here likewife to fome other Philofophers, and obferve, that fince, as we have juft now fhewn in Tab. IV. Fig. 3. the Spermatic Vein $n$, on the Left Side, does not take the fhorteft and mof fimple Way to the Vena Cava $\mathrm{C} u$, as that on the Right Side does in O; but making a Tour, does firft infert and difcharge itielf in the Kidney-Vein W; that it is in vain to affirm, that thofe Hypothefes carry the greateft Truth with them, which appear to us to be the moft fimple, and to produce

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 The Cbrifitian Pbilofopher.every thing after the fhorteft Manner; forafinuch, as there may be unknown Reafons, as here in the Cafe of the great Artery $\mathrm{D} u$, why the fupreme Architect, in order to bring about his other Purpofes, may think fit to depart from that Method, which would otherwife be more fhort and fimple in the Production of that End only.

> Sect. XXIV. The Nourifloment and Motion of the Blood, not yet fully known

Now it would be time to pafs on to the other Ufes of the Blood, namely, the Nourifoment and Motion: But forafmuch as the Ways of the great Creator, are in thefe Matters, even to this time, infcrutable to us, and that the Stricture itfelf of the folid Parts are not yet fully known, but affords room for Difputes; we judge it more fafe to be filent therein, than purpofely to offer only Guefies and Uncertainties, or Pofitions, which are not yet fufficiently received by learned Men, how probable foever they may feem; the adorable God has not however left himfeif without a Witnefs, to every one that feeks him, in numberlefs other Matters, the Certainty of which, can by no means be called in Queftion,

In the mean while it is in fome Meafure plain, how juftly the Creator fpeaking in the Holy Scriptures of Generation, fays, that Children proceed flom the Loins of their Parents. Gen. ch. xxxv. v. 11 Kings foall come out of thy Loins. And again, a Kings. ch. viii. \%. 19. and 2 Chron, vi. 9. Thy Son whbich fall come forth out of thy Loins. Since Tab. IV. Fig. 3. the feminal Veffels P P, are feparated in the Loins and under the Kidneys A and B , from the general Stream of the Blood in the great Artery $D u$; in order to carry the Matter of the Seed ta Places prepared for its Separation. Befides that Monfieur

Monfieur Vererbejen 「ays that he has obferv'd both in Men and Women, a remarkable Vein and Artery (reprefented here by $p$, ) which proceeding from the undermoft Part of the Kidneys, joyns itfelf to the feminal Veffels.

This kind of Expreffion is perfectly underftpod, fince the Difcovery of the Circulation of the Blood; and fhows with how much knowledge it has been ayply'd to all Animals, even at a time when the Structure of their Bodies was folittle known to the World ; at leaft, none could with any Shadow of Reafon afcribe the Bufinefs of Generation to the Loins, without knowing that the Blood circulated thro' the Arteries, O and P. Now that this was a Secret to all the Philofophers, and Phyficians in thofe Ages, is fo obvious, that we need not take any Pains to prove it. Can it therefore be imagin'd, that the Texts above-mention'd, which fo plainly deciare the fame, could be writ by any unimfired Perfon. And if any one fhould feek to cavil againft the Arguments we have here us'd; at leaft, he cannot deny that the faid Text fpeaks with compleat Knowledge of the Caufe, and defrribes this Matter jufly.


CONTEM:

## CONTEMPLATION IX.

Of the Nerves, and briefly of the Lymphatick Veffels, Glands and Membranes.

Sect. I. The Tranfition to the Nerves.

WHE N we were treating about the aforefad Separation of the Humours of the Blood, it would inave been proper enouigh to have mention'd thofe of the Brains and Neives, as a kind of Humours; but with refpect to our Detign, the fo important Ufe thereof, the fo wonderful Texture of the whole Series of the Nerves, which, like the Arteries for the Blood, feive for Veffels to convey thefe Humours are by much too confiderable to be handled curforily, without faying fomething particular of them too.

Now then, in order to convince an unhappy Philofopher, of the Perfections and wife Defigus of his Maker, nothing more feems to be required, than to move him to look into the Enquiries and Obfervations of the Anatomifts, and elpecially of Willis and Vieuffent, and endeavour to acquite a juft Idea of the Concatenation of this wonderful Structure, of the innumerable Multitt:de of the little Branches of the Nerves, of which there is

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not one that is made, but what is of great and peculiar Service to the Body.

To reprefent fomething of this Matter here, let him caft his Eyes upon Tab. IV. Fig 6. and confider, if each of the fe fine Branches performs its Function, (and fome of'em are fo very neceffary, that if they ceafe, they put an end to our Lives;) whether thefe Nerves that appear to the Eye of an unexperienc'd Perfon, fo irregular and confufed, and yet in themfelves are fo well difpofed, that there is not one of 'em, yea, not the fmalleft Branch or Sprig of 'em but has its Ufe; let him confider, I fay, whether all this can be performed by Chance? He that defires to be more fully convinced hereof, let him confuit the large Figures of Mr. Vieulfens.

Leaving therefore further Circumftances and Particuiars, which we might have added here, to the Study of thofe who think fit to inquire into what thofe Writers have faid upon this Head, we fiall only obferve a very few of them, that we may not appear too prolix.

## Sect. II. Different Opinions about the Matter that palles thro' the Nerves.

It was well enough known to the Ancients, that all the Nerves are a kind of Veffels, thro' which a certain Matter, that defcended from the Bran into the Mufcles, was either an entire, or at leaft a concurrent Caufe of their Motion: Becaufe, if a Nerve was cut off, obftructed, or otherwife difabled, the Mufcle to which it belonged, notwithftanding all Endeavours to the contrary, would remain without Motion.

This Matter is conceived by all to be indeed fluid; but by fome 'tis fuppofed to be a Wind or Spirit, and is therefore called the Animal Spirits, and is believ'd to pafs thro' the Nerves with a Swiftnefs

Swiftnefs like that of Lightning; it being otherwife impoffible to reconcile the unconceivable quicknefs of the Motion, which we fee performed by Creatures in fo fhort a Space of Time, with the flow Courfe of a Liquor: Upon this Foundation, there are fuppofed to be Valves, and many other things in the Mufcles, in which Suppofitions there is Ingenuity enough, if there were but enough of Truth too.

But thefe Opinions are called in Queftion Firft, becaufe it has been fufficiently proved by Chymical Experiments, that fo very yolatile a Matter is not always required towards the producing a fwift and violent Motion; accordingly, it has been feen, that by the Mixture of Oyl of $V_{i-}$ triol, and Salt of Tartir, the firft of which has little; and the other hardly any Volatility in it, a itrong and fudden Fermentat on has been prodiuced. We are taught by a like Experience too, that SaltPetre, Brimfone, and Charceal, which are not countcd among volatile Things, being mingled together into Gun-Powder, have occafion'd fuch Motions, as for Swifteifs and Force, have not yet been equal'd. The fame appears from the Glafs of Antimoily, which being a fixed Body, (or at leaft folittle volatile, that it is ableto relilt a very flong Fire for a long time, as is well kinown to the Chymilts) bas yet the Facuity of producing fuch great Commotions and Conrraćtious in humane Bodies, even fo fmail a Quantity of it, that thofe who have rried it own it to be wonderful: Others deduce the Motions of the Mufcles from Hydroflatical Laws, which therefore reed not fuppofe fo great a Swiftefs of the Nervolu Juices.

Secsidity, the Courfe of tie Nerves being now better known to thie Anatomifts, it has been difcover'd by the Complaints of the r Patients, that is was probable, that a flowly moring Matter

paffed thro' the fame; which feemed to be in forne manner more credible when it was confider'd, how improper the moift Subftance of which the Brain and Nerres are compofed, appear to be, for affording a free Paffage to any thing that was to move thro' them with fo unconceivable a Swiftnefs, as the Matter of Wind and Spirits.

Sect. III. An Experiment to prove a Nervous Fuice.

But particularly the Experiments taken afterwards by Meffieurs Bellini and Malphighi, feem to have put the Matter beyond Doubt, and to prove, that there is a tough Humour (which they called Succus Nervofus, or the Nervous Juice, in Oppofition to the Animal Spirits) that runs thro' the Nerves.

For if youl diffeet the Breaft of a Creature, in which there is fill a little Life, or that is but juft deid, and with the Fingers of one Hand, prefs the Nerve of the Midriff in fuch a mainer, that nothing can defeend from the Brain into it by this Vettel ; and atter that, go on to prefs with the other Hand, that Part of the faid Nerve, which is between the firf Preflure and the Midriff, fo as to drive wharever it contains forward into the Mictriff; it will be found, that the Midriff will refume the Motion which it hath loft, and continue it till the Humoar that was in the Nerve be quite protruded: But if you loofen the Fingers of the firfo Hand, and admit a new Paffage to that which comes from the Brain, yoir will fee after fome Time, that, as foon as this new Humour reacines the Mudriff, the Motion of it wiil be renewed. Confult Bergerius tipon the fame, Page 260. And, that one mo have fo ne folid Foundation, that the Niatter of the Nerves is of the Nature
of a Liquir, and not of a Spirit or Wind, the diligent Enquirer, Malpight, has fhewn, that by preffing the End of the great Nerve, in the Tanl of an Ox, the fame will fwell before your Finger; and if you make an Incifion in it, there will come out a vifcous Liquor like Turpentine. Which Experiment having been feveral times profecuted by Bergervs, and always appearing in the fame mpanner, it puts the faid Hypothetis out of all Doubr.

Sect. IV. Coirviltions from the foregoing Observations; and an Experiment about Mution.

IW OU id ask any Body now, that underftands this, whether it can feem credible to him, that it is brought about by Chance oilly, and not for any wife Purpofe, that a Humour, which is feparated froin the Biood in the Brain, is derived into every Part of the Body, by. fich an innumerable multitude of Tubes and Channels, in ordèr to produce Motian wherever it is requifite? To fay nothing here of the Fermentation of the Food, of Nourifhment, and fo many other Ufes, which render the Courfe of this Nervous Juice entirely neceffary: And can it be without an End, that this Humour has one wonderful Property, (more we cannot reckon here with any Certainty) that it is fitted, togecher with the Blood of the Arteries to produce thefe Motions in the Mufcles ?

For that the Arterial Blood does likĕwife very much conrribute to Motion, may appear from the Experiments of Bartholinus; by which wé fee, that a Limb or Joynt is render'd lame and roid of Motion, as well when, by binding the Artery, the Blood is hinder'd from coming into the Mufcles, as when the fame is done to a Nerve. And can any one obferve this come to pals, after
uch an amazing manner, not only in one, but in 11 Men and Beafts toa, and fo many Wonders roduced thereby; fuch as the external Motions Walking, Swimming, Flying ; and the internal of the Heart, Arteries, Stomach, Bowels, and fo nany other Parts, ferving both for the Support ind Procreation of Animals; and, can he then Ifribe all this to mere Chance and ignorant Caues, without thinking that he will be taken, by sife Men, for a blind or obftinate Fool?
iect. V. The Nerves of Hearing are extended likewife to the Tongue.

Now let a Man confider farther with himfelf, whether the great End of our Creator, to furnifh is compleatly with every Thing that is neceffary for s , does not plainly appear in the following Cafes : Firff, That the Nerves of Hearing do diftribute their Branches to the Mufcles that move the Ear, to the end, that as foon as we are warned by the Noife, which affects the Nerve, the other Inftruments may be immediately put into a Condition of erecting the Ear, in order to liften the better: This is obfervable in the raifing the Ears of many Creatures as foon as you fpeak or call to them; for the fame Reafon it is, that this Nerve fends othe Branches to the Eyes alfo, that upon the hearing of any uncommon Sound, we may prefently look about us; and likewife, be ready, without Delay, if fpeaking or calling for Help be neceffary: for which Purpofe, the faid Nerve of Hearing has a Communication with thofe of the fifth Pair, and the Parts that produce Speech.

## Sict. VI. The Nerves of Tidfing.

Secondl, That the Nerves which ferve as, produce Taffe, and which, accordingly to Whas, make a tioth and fixth Pair, to likevile fend own Branches to all thofe Intiruments chat are neceitay for Maltification or Chewing, to render the Adion and Talte lively and ready; they likewife feal other Baanches to che Nole and Ejes, to the endy that in the Chotice of our Victuals we may beatfifted by the Sinell and Sight: And laftly, thas while ali che formentioned Properties are exerted, to the end, that nothing may be wanting, other Bramelhes ace iratimiteed to the Glands for Spictian that this Humowr may be lipplied in abundance? and the Mouth and Throat moiften'd cherewith, during the Aftion of Chewing and Tatting.

SECT. VII. Nevees thas ifotute tuith, or twithats car: Cajens.

Thirili, Can any che fee withorte Aftomifnment, that: Nerves, which feem to be made of the lame Matter, and mainain'd by the lame Food, can pertirm fuch yarious and differen: Functions? That the firf, which come out of the Marrow of the Bick, as the laid Marrow does from the forepart of the Brain, thould entirely be governed by our Willy in the Motions prodoced by them in our Arms, Legs, Ure and accurdiagty ciufe the Mulcles to operare, of to ceafe working; whereas the other, that have their Origin in the Cordodars, or Hinder-patt of the Brain, do continually atd incellanty move chofe Parts to which they are trantmitted, as fong as our I lite lafts, withour the lealt Subjefiea to our Will.

## Sect

Sict. VIII. The Parvagum and Intercofial Nives.
W I flall give a Proof thereof, in Tab. IV. Fig. 6. which, by reafon of its Smallnefs, can only fhew wis a little of it: A B is the Paruegum, or Wan-dering-Nerve, as it is called by the Ancients, becaufe it is extended to fo many Parts; by Willis it is called the eighth Pair; of this, A reprefents the uppermolt Plevus, and B the tolowing; after fome Ramifications to the Muicles of the Throat and Neck, there goes out of H, a Branch $a$, to the upper-part of the Wind-pipe, there come leveral other from $B$, which extend themfelves to the Heart, to the Percardium, and to its Auricles and Blood-Veffels, ard one bigger than the reft, C, which runs to the Plexus Nervofus of tine Heart F ; from the Plexus B, there fprings litewife the recurrent Nerve D on the right Side, and E from the Body of the Nerve itfelf on the left Siae, which mores the Wind-pipe.

Befides thefe, there goes at $e$, a great Branch to the Vein of the Lungs, and to the Heart at D, and from the Plexus Nervofus of the Heart F, runs a Branch e, to the Artery of the Lungs, and a great many, $f$; to the Heart.

Moreover, there pafs from this Nerve a great many Branches $g$, to the Lungs, and the Veins and Arteries, and Bronchi of the Lungs in the fame, and fome, $h$, , to the Gullet.

Finally, this fame Nerve divides itfelf into two Branches, G H, on each fide, which afterwards uniting again in I, fpreads an unfpeakable Number of Branches in the Stomach; and, after laving fent fome Sprigs to the Plexus Nervofus, lying in the Belly, ends there, as far as we have been able to difcover.

The fifth and fixth Pair of Nerves (marked is and 6) the firf of which does in a manner furnifh all the Parts of the Face and Mouth with Nerves, make a great Nerve by the Branches which they fend out, and which are commonly called, tho not very properly, the Intercofal; this, after having made a Plexus above at $i$, and tranfmitted out of it a Branch to the contracting Mufcle of the Gullet, proceeds forward to a fecond Plexus K , which lies in the Neek; and after having fent out of it fome Fibres $\lambda$, to the Gullet and Wind-pipe communicates farther great Branches L, to the Plexulf Nervofus of the Heart. Again, this fame Nerve makes a third Plexus at N , and then defcendy thro' the Breaft, where fome Nerves, $n n$, are inferted thercin from the Back-bone; and coming into the Belly, tranfmits two great Branches, $p P$, downwards, which makes other Plexus ars ST U $u$, and from thence communicates Nerves to ali the Inteftines of the Belly, as may be feen in W, paffing to the Bowels.

To conclude, there are none of the Entrails eia ther in the Breait or Belly, but what receive Branches from the two Nerves we have here been defcribing; viz. the Vagus and the Inteicofitio lis. Whofoever defires to fee them minutely $\mathrm{rt}^{-}$ prefented, may confult the famous Works of Mel. fieurs WTilis and Vieudfens; whofe Figures from Branch to Branch, together with the Courfe ol the Nerves in the Body, before they were Publifhed, were compared and examined by another great Anatomift, being founded upon Experimental Diffections of above 400 Bodies in the fpace of fifteent Years.

One might here make infinite Remarks upor each Duct, or Courfe, of thefe Nerves; upon theis Infertions into one another; upon the feveral Part! which receive their Nerves from the faid Bran
ches; upon the Plexus that appears therein, and which confitts of the Concurrence of many Nerves of a different Original; as at F, for juftance, which is equally compofed of the Sprigs of the Parvagum and Intercifale; to the end, that the Heart, which is thereby moved, might receive its Nervous Juice from the one, in cafe the other fhould Fail : To fay no more, can any Body imagine, that there Difpofitions have been made without Wiflom?

BECT. IX. Convictions from the foregoing Obfervations.

Icanno t forbear putting this one Queftion to Man, that is ftill fo unfortunate, as noe to be ble to difcover from all thefe things, the Wifuom f his Creator; viz. Whether he can, without rembling, confider, that all this great Compoition of the Wandering and Intercoftal Nerves, by which his Heart, Lungs, Veins, Stomach, Guts, iver, Kidneys, and every thing elfe, that contriutes to the fupport of his precious Life, are movd, is performed entirely without his own Will and Oncurrence? And, that there is fcarce any thing Ife left to him, befides the command over thofe verves which ferve for its external Functions; hilft, in the mean time, he is not able to coninue one fingle Inftant the Action of thofe Nerves y which he lives. Nor can the moft obdurate 4theift, or the frongeft Mind (as they love to call hemfelves) find here any Evation to fatisfie his diturbed Confcience, that he is not abfolutely in he Hands of another, upon whom his Life does ontinually depend; at the fame time that he is orced to confefs, from his own Experience, that Il the Motions contributing thereto, are proluced in him, without, and againft his Will, by

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Nerves, whofe Operations he can neither directly obftruct, nor promote.

If now this great Mover of all Things be Wife and Powerful, which appears undeniable from the Courfe and Operation of the Nervcs, from their Difpofition to perform their Funetions, and from there abfolute Neceffity for Life, and the Prefervar tion thereof; can the Atheift, without trembling, confider, that he, by thus imputing all to Chance, or fomething that aets without Wifdom and Know ledge, does as far as in him lies, rob God of his Attributes, and treads them under his Feet? Mule not his own Confcience, foretell him that one time or another he will jufly feel to his Mifery and Confurion, this Power which entirely belongs to another, and which he tinds abfolutely neceflary towards the Prefervation of his own Being, and from which no Creature whatever can deliver him, any more than he can free himfelf; neither can he prevent his own Death whenever it flall pleafo the great Preferver not to fuffer the Machine of his Body continue any farther in Motion, and the Nerves, which do only perform their Functions, thro' his Influence, ceafe from the Exercile of the fame.

## Sect. X. The unluappy Condition of the Atbeits.

Ho w much more happy than is fuch a one, who from Contemplating the Difpofition and Structure of his Nerves, and the Confequences thereof, has learned to know himfelf fo far, as to be experimentally convinc'd, that his gracious Creator hascaufed all the Nerves which ferve for the fupport of his Body, for the Motions of his Heart, Lungs, Stomach, Éc. for the Circulation and Separation of his Humoms and other Neceffaries of Life, to operate for the refpective Purpofes, by an imme- even without his Knowledge, or ary Perception thercot? And who having farther obferved how many Nerves, by the wife Providence of his Maker, are fill Ifft for the moving of other Members, aceording to his ownDifcrerion wholly; I Gay, who is there, that atter having ferioully confider'd all thefe things, does not find himfelf obliged to ufe them all to the Honour and Glory only of his adorable Creator?
And with how much more tranguility (to repeat it once again, fince we can never reflect upon it too often) may fuch a Man obferve, that this whole Frame of his Body, that both his Life and Death are abfolutely in the Hands of fo gracious a Creator, when he learns, from one kind of Nerres (by which he lives, and which being out of his Will and Power are only moved by his Preferver) that his conftant Dependance is on him; as he is again taught by another, the Operations whereof are in fome Meafure depending upon his own Will, to difcharge his bounden Duty of Service and Gratitude to his bountiful Mafter ; I fay how much more eafy to himfelf, will the Life of fuch a Man be, than that of him who, againft all the Proofs which demonftrate, after the moft irreiragable Manner that there is a God, againft all the Convictions, on onc Hand, of the great Creator's Power over all that he has made, and which he continually and immediately preferves, does moft imprudently deny him: And on the other Hand biatipemounly employ his Tongue and the reft of his Members in defpifing that God, to whofe Honour only he ought to ufe them? Oh that the deplorable Atheift would conlicer and underftand thele. Things rightly!
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## Sect. XI. The Nerves of the Midriff.

$\dot{A}_{\text {ND }}$ if this be not fufficient to convince every Man of the Views and Defigns of a wife and merciful Creator, in the Difpofition of the Nerves, let him caft his Eyes upon Tab. IV. Fig. 7. in which he will find the Reprefentation of the Midriff, which we have caufed to be drawn for this purpofe only.

Now to fay nothing of its circular Mufcle A A, and another $B$, its tendinous Part $C$, the Paflage D for the Gullet, and E for the Vana Cava; as alfo the Blood-Veffels that feed it, GHI; of which every Body that underftands their Ufes, can add a great deal more, in order to prove the wife $\mathrm{De}^{-}$ figns and Purpofes of the great Creator: Can any one be fo blind, who knowing how neceffary it is that the Motions of the Midriff fhou'd depend upon our Will, when in extraordinary Breathing, in Singing, Speaking, and other Incidents, the famt is requifite; obferves here, that two Nerves K K, iffuing out of the Nerves of the Neck (as they do from the Medulla Spinalis) and therefore do belong to thofe that are fubject to our Will, are beftowed upon the faid Midinf? And when he is moreover convinced, that it is no lefs neceffary that the great Work of Refpiration fhould be continually carriedon, even whilft we fleep; and how inconvenient it would be, that whilft we are waking, if we happen to fix our Thoughts upon other Matters, we fhould be obliged every time to attend to the Bufinefs of Refpiration, and to divert our Thoughtsfrom all other Things to this alone: Can a Man, I fay, without acknowledging the gracious Purpofe of his Maker, obferve that two other Nerves, L L, are communicated to the Midrift, which (as it happens alfo to the Bowels, Heart,

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5.) do continue the Motion thereof without our Concurrence, and when we leaft think of it, and or that rcafon take their Rife from the Intercoftal Neiver, which are made for that Purpofe?
jec t. XII. The Nerves of the Intefinum Rectum.
Thefame may be obferved, befides other Parts, in the Intefinum Rectum, which requires one Motion fpontaneous and independent of our Will, in orler to bring forwards that which is contained herein; and again, a fecond Motion, which is oluntary, in order to beexerted with the greater Force at the time of the Difcharge.

The Words of the accurate Anatomift Verbeyen ire very remarkable upon this Occafion: The Intetines have, among others, their Nerves of the great lexus Nervofus in the Mefentery, and all of them ure Jerviceable to the Motions performed without our Will (Functiones involuntarix.) But the Inteftinum Rectum, and probably alfo that Part of the Gut that is mimediately joining to it, has other Nerves from the lower "art of the Medulla Spinalis, by the belp of which the Difcharges of the Belly are performed, according to, and n confequence of our Wid.

## Sect. XIII. The Vafa Lymphatica.

Now as the Blood which goes thro' the Arteies to the Parts of the Body is brought back again hro' the Veins, the Enquirers into Nature have ikewife afierted, and not without great probability, that the Humour which is feparated from the Blood in the Veins, and which is communicated oy the Nerves to all the Parts, is brought back aifo by another fort of Veffels (calied the Vafa Ljmploatica) to the Blood, and fo performs as it were another Circulation.

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Now whether this Lympha, or tranfparene $L_{i}$ quor, proceeds from the fmalleft Side Branches of the Areeries, in each of which at the fame time a Nervous Sprig difcharges itfelf, we thall not hear farther examine, but refer fuch as delire to hrow it, to the fecond W ork of Monfieur Vienffens: This is true at lealt, that thefe Vafa Lymphatica are oblerved to proceed from all the Parts of Creatures (the Brain excepted, that being yet doubtful) as lihewrife that the Courfe of their Liquot in $q q$ (Tab. I. Fig. 6.) proceeds to the Ductus Thb. racicus Orr , and fo to the Vena Subclavia, $u x$, and other Places directly to the Veins; that they have innumerable little Valves, in order to prevent the Return of the faid Liquor, and fo appear like Links of little Chainsqq; that they touch upon feveral Glands in their Pafiage, or procced likewife from fome. Thofe who defire to have any Notion of this Matter, may confult Tab. IV. Fig. 8 where it is fhewn how thefe Vafa Lymphoatica LL L Uc. coming out of the Kidney's B B, and other Parts of the Body, have a Communication wit the Glands F, G, H, I, K, and difcharge themfelves into the Receptacle of the Chyle D, in ordef to carry their Liquor on to the Blood by the Ductu Chylious E , which is here reprefented as cut of and in the mean time (as we have faid above) help to make a Stream for the Circulation of the Chyle.

Now how unknown foercr may be the true Source or Origin of thefe Veffels, forafinuch as moft of the Experiments have been made upon Beafts, and defcribed from them, the Opportunitics being very rare of opening Men fo quickly after their Death, in order to difcover thefe Vefiels which do prefently-difappear, for which reafor fome principal Anatomifte have endeavoured to Fhen there Courfe by injeeving Quickilver, pre-
, ured for that Purpofe, into them ; yet this ar leaft strue, that they do difcharge all their Liquor into che veinous Blood, and fo render the aforemensioned Service to the Chyle.

## SECT. XIV. The Glands.

We fhall pafs over the Difpofition and Structure of the Glaind's, it being ftill fubject to too many Differences and Difputes in the chiefeft Matters, but which perhaps may furnifh Pofterity with new Matter to convince the Unbelievers, of the Wifdom of their Creator; however it appears in the mean time plain enough, that they cannot attribute it to meer Cbance, or ignorant Caufes, that the faid Glands are ufetul to fo many, if not to all the Separations of Juices ; and that this wonderful and as yet unkinown Effeet, is produced in their Bodies. viz. That the Blood (which in it felf is in a manner infipid) being brought into the Glands by its Veffels, the Humours that are feparated from it in thofe Glands, are thereupon impreguated with fo many different Tafts and Properties. Thus that which is feparated in the Kidneys is Salt, as are likewife the Teais and the Swent, which proceed from the Glands of the Ejes, or come out of the Pores of the Skin; from the Liver there iflies a bitter Gatl; from the Glands of the Breafts of Females, a fweet Milk ; from the Glandula Salivales, Spittle, ©゙c.

Now every Body knows, that upon the ObftruEtion or Ceflatiom of any of thefe Humours, gricrous Sickneffes and Death itfelf does fometimes follow, and that almolt all of ' cm , how different foever their Nature be, are abfolutely neceffary to Health or Life. The Nerves likewife, and the Arteries, which carry the Blood and the Nervous faices thercto, or difcharge themfelves thercin; the Veins and Iymphatic! Veffels which bring
back the Blood and Lymploa, or what is feparated from thence, and which contribute to a Paflage or Way for the feparated Juices, where they can be ufeful in fo many particular Veffels already difcovered; I fay, all thefe things do abundantly inAtrict ws, that each of 'em are formed for a particular End, and are therefore placed exactly where they can be mof ferviceable; the rather, fince Anatomits have difcovered (See Vieuffens in $8 v 0$, p. 238.) that altho' there is lietie Motion or Senfation in them, yet, in refpect of their Bignefs, more Nerves are found in tnem, than in any other Fart of the Body,

## Sect. XV. The Membranes.

Much might be here faid about the Membranes, and which would powerfully fupport our Defign, efpecially if we would here propofe all the modern Difcoveries that feem to be only in their Embryo, and have not yet attained their full Perfection; this is certain, that they have the following Ufes:

1. That they ferve to cloath or cover fome Parts, as may be obferved of the Pleura in the Breaft, and of the Peritonaum in the Belly.
2. To form Tubes and Veffels, as in the Blood, and Lymphatick Veffelsand Inteftines.
3. To join or faften lome Parts together ; thus are the Inteftines faftene to each other by the Mefentery, and both together to the Back.
4. To divide Cavities into more Parts; thus the Mediafinum divides the Breaft into two Spaces, under which Head we may likewife reduce the Membranous Valves in the Heart, Veins, Lymphatick Vefiels, ćc.
5. Not to reckon that they are by many efteemed to be true Inftruments of Feeling, and perhaps of other external Senfes.

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6. There is yet a greater Service performed by them, viz. That many of 'em confift of mufcular Fibres, which by their Contraction or Squeezing, when they make Tubes or other Cavities, are proper to protrude that which is included in thofe Membranes ; as we fee it happens in the Stomach, Guts, Bladder, Arteries, and the like.

Sect. XVI. The Dura Mater, or thick Membrane of the Brain,

Monsieur Pacchionus thews, that according to Anatomical and Praitical Obfervations, the thick Membrane of the Brain, commonly called the Dura Mater, has the fame Property of protruding the Humour feparated in the Brain into the Nerves; and fince this Membrane does inveft all the Branches of the Netves, how many foever they be, he thinks it is very probable that by a Contraction of its Fibres (like that of the Periftaltick Motion, which happens in the Inteftines) the $\mathrm{Hu}-$ mour is driven forth into the Nerves; I leave this Matter to farther Enquiry; but if one may here mention that which feems very likely concerning it, I fhould think, that unlefs fomewhat of that Nature did occafion the Protrufion of the Nervous Juice, fuch a Power or Faculty could not be deduced only from the Motion of the Heart; forafmuch as the Matter of which the Medulla Spinalis and the Nerves are compofed, does not feem proper to afford a fwift and ready Pafiage to fuch a tough and Turpentine-like Humour, as the famous Malpighi defcribes it to be. Moreovet, it feems to be a neceffary Confequence, that in cale the Heart were the only, or chief Caufe of the Nervous Juice, a Nerve being tied or bound, as is ufual in Arteries and Veins, would fwell up againft the Band, which many who have made this Experiment complain

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complain does not happen; but if the Coneraction of the Dura Mater, which encompaffes the Nerves, does, without any vilible Affiftance from the Heart, alone protrude this Humour, every Eody mult own that this Periftaltick Motion, by the Com. preffion of a Sering or Band, wrould be forced to ceale; whercupon, that which we experience would follow, viz. that the Nerves would not be abie to fivell and expand themfelves by the protruded Matter againft the Band.

For a furcher clearing of this Matter, I could have added fome Practical Cafes, which, withuut the Hypothefis of fuch a Motion in the Nervous Membranes, would feem unintelligible, and yet, being handled upon this Foundation, mect with the defired Succels, after having tried feveral other Means in vain. But this is not a time to feeab of thefe Things here; Ict every one confider and reflect by himfilf, whether upon feeing the knowin and undeniable Ufes of the Membranes, he muft not acknowledige and be convinced of the Wifdom of his Creator.

## Sect. XVII. The Flexibility of the Membranes.

To fpeak fomething of this Matter: Forafmuch as it was neceffary for the Support of Life, that the Blood and Nervous Juice fhould be carried to all the Parts of the Body, and brought back again, it was no lefs necefliary that Veflels, fuch as the Arteries, Veins, Nerves, and thofe belonging to the $L$ ympina, fhould be formed for that Purpofe : But fince, befides this, the Body was to be moved, and that therefore Inflections and Angles were to be made in its Joints, it feemed requifite that thefe Tubes ought likewife to be flexible, to to the end that (for Inflance) the Arteries in the Armand Hand might ferwe for a Pafiage to the Blood,

Bloal, as well when they were bent at the Elbow or Fingers, (at whick time fo many Angles and Infleceions are produced,) as when the fane Arm or Hatd beng fterched out, the faid Tubes were dikewife extended in right Lines.

Now let every Man ask himfolf, afrer having oblerv'd the aforefaid Matters, and difcovered the Tubes adapted to all thefe Ufes, whether he can be fatisfy'd in afcribing 'em barely to uncertain and ignorant Caules? But on the contrary, whether the greate!t Artificer in the World must not have employ'd much Study and Thought to adapt 'em all to Scueral Ends? And when he fees Veffels compos'd of fuch thick and ftrong Membranes, and of the utmof Flexibility at the fame time, not only for forming their Offices as Receptacles, but alfo pos'd continually to protrude what they contain; can he pretend that they are form'd without Wifdom? Nay, muft he not own himfelf the moft unreafonable of all Men ? being obliged to confefs that no fmall Wifdom is requifite towards the Inrention of the fame; and yet when he fees them invented and fram'd after the beft manner, will perverlly maintain, that it all happens without a wife Contrivance or Direction.

We flall pafs by other Remarks concerning the above-mentiored Glands and Membranes, having divelt long enongh already upon 'em; as alio all that might have been added farther upon many other Matters, fuch as the Ligaments or Bands by which the Bones are joined together ; of the Fat, Skin, Cuticula, and the like; thofe who have a Mind to examine into what is already difcovered thercupon, will find Caufe enough to extol the Wifdom and Goodnefs of the Creator.

## CONTEMPLATION X

## Of the Mufles.

Sect. I. The Trangition to the Mufcles.

NW in cafe that the foregoing fhould not appear fufficient to convince every Man fu:1y, and entirely, of the great Ends of his Creator, and of the moft wife Manner of executing the fame; (tho' not hardly to be fuppofed, of fuch as have thoroughly comptehended what we have already reprefented to them thereof) yet, at leaft, this great Truth will appear to be placed beyond the Reach of all Doubting, by the fingle Enquiry oniy into the wonderful Compofition of the Mufcles of a humane Body; which Mufcles are, in a manner, the Inftruments of all its Motions. And in cafe any Body fhould view, with an underftanding Eye, the Infertion, or Faltening of the fame to the Bones (which are likewife fo exafly adapted for the making of Limbs and Joynts, whereby Motion may proceed without Interruption) their wonderful Contexture, and the amazing Power and Strength communicated to them, tho' confifting of fuch exceeding fine and fiender Fibres or Threads; I fay, whoever contemplates any of thefe Particulars, muft needs acknowledge in all of 'em, the Hand of a great and mighty, wife and good Creator; the rather, becaufe he has an Example thereof in the greatef Philofophers and Mathematicians, whom the Contemplation of there

Wonders, and the Enquiry into the Wifdom that thines out of them, have often compelled to aci.nowledge the Slory of God in thefe his Works. For onc $\operatorname{lnftance}$, amongt a great miany others, one vieed only perufe the Dedication of that Book, that Monfieur Borelli publifhed, about the Motion of Arimals.

## Sect. II. Of the Muclesin General.

No w not to ask whether any Body, that urderfands never fo little the Structure of Mufcies, could believe, that thofe which move the Tongue, or the Fiands of a Man (to mention no more of 'em) are made without $D e f i g n$, without Wifdom, and by Chance only; and that all the fo neceffary and ufeful Functions, performed by them in the Bodies of Men, are produced by ignorant Caufes: Can it be imagined, that the Power and Goodnefs of our great Creator does fo far extend itfelf towards us, that the Mufcles in a Man's Foot have been adapted by him, to ferve upon occafion, in the fead of Hands ? And yer, as ftrange as this may feem to be, we have feen, not leng fince, a Man, who being born without Arms, could ufe his Feet almoft for all Purpofes, and among others, write a fine Italian. Character with the fame, as faft and as accurately, as another good Writer was able to do with his Fingers; to fay nothing of many other of his Motions, fuch as fhuffling of Cards, and playing therewith, and managing a good Number of them fo dextroufly, that he could not have done it better if he had the ufe of both his Hands: Now in cafe thofe Mufcles that move the Feet, had not not been of proper Structure for the like Purpofes, it would have been impoffible that he could have performed all this with his Feet.

And are we not taught by the fmalleft light of Reafon, that when we fee fluch a wonderful Machine,

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Machine, compos'd of fuch Joynts, as we only ufe for Supports of our Body in Walking, Running, and other little Purpofes, we are bound to thank our Maker, who has contriv'd the Structure of our Mufcles, that are yet fo much more ufeful and benefieial than any Body, éven the very greateft Philofopher, could ever have believed, were it not that Experience has render'd it fo obvious even to the meaneft Capacities.

## Sect. III. The Defcription of the Mufcles.

However, to enquire a littie more clofely into the Structure and Difpofition of the Mulcles, and to reprefent the overflowing Wifdom of our adorable Creator, by fome few Obfervations upon the fame, let us contemplate Tab. V. Fig. 1. 2, 3. which will give us a Sketch of the external Strueture of fome of the Mufeles, the great and principal Inftruments of all our Motions, and by which alone we exert our Strength.
I. A Mufcle then (not to mention here its Artery, Vein, Nerve, and Lymphatick-Veffels, which are reprefented in Tib. V. Fig. i. a bctied together) does confift of a Number of fleflify Fibres or. Threads B, ruming Parallel mofty, and ai equal Diftance from each other, and faffen'd at Top and Bottom to a tough Body, called a Tendon, $A$ and $C$.

Acrofs thefe flefhly Fibres B, there run others E F , which are likewife tendinous, nervous, or membranous; but as flender as fome of 'em are, they are all very tough, and not cafy to be broken, and are regularly interwoven with fleflily Fibres.

Now in cafe the Tendon A, the Fibres whereof are here fhewn to be a little feparated from each other, be faften'd to a Bone that is unmoveable;


and the other C , to one that is movable, and can ield to the bending of its Joynt ; and afterwards ach of thefe mufcular Threads B, are contracted, or render'd fhorter by any Force, be it what it will; it is plain, that the Tendon $C$, will draw he Bone that can follow, and to which it is faten'd, towards the other Tendon A, and fo will send the Joynt that lies between $A$ and $C$.
The Anatomifts are wont to call the Tendon $A$, which is faften'd to the immovable Bone, and tovards which the Motion is made, the Head of the Mufcle; and the other C, faften'd to the movable 'art, the Tail ; and the flefhly Threads B , with he tranverfe ones F E, the Belly of the Mufcle.
Iect. IV. The Strength of the Mufcles confifts ini their many Fibres.
2. It appears from hence, that the more Fibres here are in B, or the Delly of the Mufcle, which eing contracted do draw, the ftronger will be the Ietion, of fuch a Mufcle, which is alfo found rue by Experience.

## Sect. V. Double Muclës.

3. Now to the end that a Mufcle may exters reater Force, it will be neeeffary, that it fhould onfift of a greater Number of Fibres B, which mäy aufe it to encreafe very much in Thicknefs, and fo' 11 that Place, in which other Mufcles ferving for ther Purpofes, might have been lodged.
Can any Body then, without Amazemént, refleat pon the moft ingenious Manner which it has pleadd the wife and gracious Creator to ufe, fo to difofe many more Fibres in the fame Spacé, in orer to make the Mufce fo much the Stronger, that here fhall not be requir'd much more Room to place hofe Fibres? viž. by leaving to a kind of Mufcles, hat are neceflary in producing a ftrongêr Motion
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than
than others, the ufual Breadth or Space, whicl they are to fill after fuch a manner as we fee ill Tib.V. Fig. 2. in which A B C is the Head of thi Mufcle or Tendon, faften'd immovably at A, anc reprefented in this Figure as cut off; ED is thr Tail of the other Tendon, that draws the Jointte itfelf; and between both of them are two artfuil Rows of Fibres F and G; being faften'd to thi Head ABC, and running obliquely to the Tai E D, in which they are inferted, from whence i appears, that thefe two Rows of mufcular Fibres F and G, being forcibly contracted, the Tendot E D, and the Bone faften'd to it, which is move able, muft be drawn towards A, with this Advan tage over that which was fhewn before, in Tab. V Fig. 1. that here (Tab. V. Fig. 2.) many more Fi bres, as $F$ and $G$, can be put in Action in the fame Space, whilf they run after this manner obli. quely, as it were acrofs, than when they wers extended, as in the former Fig. I. directly only and at equal Diftances from each other.

## $\mathrm{Se}_{\mathrm{E}}$ т. VI. Mufcles yet more doubled.

We may obferve again, in Tab. V. Fig.3. that thefe mufcular Threads are, after a wonderful manner, upon fome Occafions, much more doubled: A is the Head, and B the Tail of the Mufcle, the which laft $B$, by two cendinous Branches that are extended towards A, gives an opportunity for the ranging a much greacer Number of flefhy Fibres it fuch an exact Order; fothat the Fibres C and D. being falten'd to GA H, or the Head of the Mufcle, (which is fuppofed immoveable,) when they are contractedin their Length by any Force, do each of them draw their Branch F, and thefe two Bran ches $F$ and $F$, draw the Tendon $B$, and whatevet is faften'd thereto, and is moveable towards $A$, which, if it were to be performed by Fibres run-
ning direatly or ftreight from A to B , as in Tab. V. Fig. I. would, by the greater Number of them, compofe a Mufcle almoft as thick as this Mufcle (Tab.V. Fig. 3.) is long : If what we have here faid, does not fet this Matter in fo clear a Light as to make it fully underftood, the Reader may confult the Demonftration of the Force of the Mufcles Secr. XVII.

Now will any rational Man fuppofe, that all this isfo nicely adapted to fuch great Purpofes by Chance, or ignorant Caufes? And can he difcover hercin no Wifdom of the Creator? When at the fame time, unlefs he would be accounted a Fool, or Mad, he durft not deny, that all the Parts of a great Rammer for driving Piles, at which fo many Men are obliged to draw with Ropes, is form'd without Wifdom and Defign.

## Sect. VII. The Mufcles of the Fingers:

4. For farther Conviction, let us make one only Remark upon fome of the Mufcles that bend the Fingers; we will therefore confider the Mufcle A B (Tab. V. Fig. 4.) as it is faften'd with its Head or upper Tendon near the ElbowK, whofe moving Threads or flefhly Fibres extending themfelves from B to A, do compofe the lower Tendon C, and this confifting of four Parts, tranfmits a Branch to each of the remoteft Joints of the Fingers, wherein it is inferted at $D$; now when the flefhly Fibres A B, are contratted, the Mufcles being immoveable at K, it is eafy to obferve, that the third Joint of the Fingers D DD D, is thereby drawn towards B, and all the Fingers inflected; the rather, if you fuppofe farther, that the Mufcle GF (which is reprefented here out of its Place, and lying above AB) is likewife contratted in its Fibres F G, and by its four Tendons, GE; draws over forwards the fecond Joint of the four Fingers:

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Now let every one ask himfelf, whether he can fuppofe, that it is by meer Chance, Firft, that thefe Mufcles A B, and GF, which bend the extreameft Joints of the Fingers, are placed fo far above the Hand, and even as high as the Arm, and yet extend themfelves by their long Tendons CD and GF to thofe Joints which they are to move, fince, if they had lain in the Hand itfelf, they would have render'd it very unfit for an accurate eafy handling of Things? Forafmuch, as thefe Mufcles being obliged to exert a great Force, do require many flefhly Fibres, which, when they were contracted and put into Action, would caufe the Hand to fwell to a great Thicknefs.

For, that thefe, and other Mufcles, fuch as thofe defcribed by AB, do upon their Contraction require a greater Thicknels, may appear to every one, who upon clofing with fome Force, one of his Hands and turning itinto a Fift, does with the o. ther Hand fpan his Arm below the Elbow; in doing which, he will remarkably feel the Mufcles thal lie there to be fwelled: Which Thicknefs, if i were continually produced by fuch great Mufcle! as lie in the Hand, it is plain, would, upon many Occafions, embarrafs it the Exercife of its Function Secondly, Whether he muft not acknowledge, tha it is a Contrivance beyond the Power of an Ignoran Caufe, that the Tendons G E, of the Mufcle F G do make a kind of Door or Opening at E ? b) which Means the Tendons C D of the Mufcli A B, pafs like a Thread thro' the Eye of a Needle in order to hinder thefe laft in the numerous Mo. tions which the Fingers make upon many Occali ons from being diforder'd by Diliocation or othe Accidents ; or at leaft, that the Motions of all th Tendons, lying near or upon each other, may n) be fo loofe and uncertain.

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Thirdly, Becaufe there would be Danger upon the Contraction of the Mufcle A B, that the Tendons C D, which go to all the Joynts of the Fingers fhould recede from the fame, when they were bent upwards, and' occafion feveral. Inconvenienies, by fretching theSkin too much: Can any one lee, that each of thefe Tendons is encompaffed with a kind of membranous and very ftrong Sheath, which, without obftructing their Motion at all, makes it remain faft to the Bones of the Fingers; rot to mention the great Band juft above the Hand, which encircles the Arm in that Place like a Ring, and at once binds together all the Tendons of thofe Mufcles that go to the utmoft Parts of the Fingars, preventing them upon great Inflections from eceeding too far from their proper Places; I fay, san any one fee all this, without acknowledging the Defigns of a great Creator;

## Sect. VIII. of the foynts.

God has been pleas'd to manifeft his Power and Glory after very different and furprizing Ways, in endowing the Bodies of Men and other Animals with many Kinds of Motions.

In order to prove the fame, he who would be convinced of the greateft and mof important Truths, and of the Attributes of his adorable Crettor, need but enquire a little more narrowly into the Inftruments that ferve for fuch Motions? For which purpofe it may be of ufe to unexperianced Perfons, it we fet before their Eyes a rough and general View of the Structure of the Foynts in this Place ; referring the Particulars to the Place where we fhall treat about the Bones, \&c.

The Joynts of a Man neceffary to produce the Motions between the two Bones CDE, and I B (Tab. V. Fig. 5.) are moft commonly of the following Structure ; in the firf, CGE , there is found

$$
\text { L } 3 \text { a larger }
$$

a larger or fmaller Cavity CDE, in which the protuberant Part, C DE F, or I of the other Bone is faften'd after fuch a manner, that they can both turn and move in each other: Now in cafe this protuberant Part, C DE F A, being fpherical, or round, is exactly adapted to the Cavity CDE, it is eafy to fee, that the Bone B A may be moved at Pleafure upwards or downwards, and on eithei Side; but in cafe the faid Part, I, were not per featy a Parr of a Sphere, but round and flat, like a Piece of a Wheel, and then inferted into its Cav vity, it is plain, that the Bone B A might be mo ved upwards and downwards, but not fideways.

A Motion analogous to the former, may be obferved in the Shoulder or Hip ; and to the latter in the Elbow or Knee, fome little Circumftances excepted, which in the main, do not alrer the Cafe, but ferve for other Improvements.

Now can the beft Mechanift in the World com pofe or put together any Joints after anothe! manner, whereby fo great a Force may be produ: ced, with fo much Conveniency, and fo little Dan ger of being diforder'd by common Motions? Yea, we know that if one Bone turned upon the othel with a fbarp Point, in ufing any Force or Violence, it might perfectly mifs its Fulcrum or Sup port in many Accidents, and the Point run the Rish of being broken, or at leaft disjointed: It woulc likewife have been impoffible, after the fame manner, for a Bone of any common thicknefs, to make fo acute an Angle as the Elbow does with the Bone of the Arm; nor could the two Bones be in fuch a Pofition, with refpect to each other, and paralle with the length of a Man, as the whole Arm is, when extended downwards on the fide of the Body, or upwards on the fide of the Head. In other Forms or Modes of Joints, befides thofe which appear in Animals, other Inc onveniencies will refult from them.

To prevent all which, what fafer Method can be made ufe of to produce the Motion of two Bones, than that which is reprefented in Tab. V. Fig. 5. not by the extream Point thereof, which might be eafily broken or diflocated, but by a Centre I, which you muft fuppofe to be in the middle of the fpherical Protukerance, CDEF A, of the Bone A B, or if it be Cyindrical, about the Line, which runs length-wife thro' the Centre thereof, and of which I is the extream Point, as we fee it happens in our Joints.

I have dwelt the longer upon thefe Matters, becaufe if ever this Book fhould happen to fall into the Hands of fuch a Philofopher, who cannot be convinced from the Structure of his Body, of the Wifdom of his Maker he might hereby be excited to employ all his Underftanding, Philofophy, Mathematicks, and what o her Learning, or Talents he may have acquir'd, and to try whether, befides this Structure of the Joints, he can find out any other Machine or Contrivance that may be fo very Serviceable, and of fo little Danger, as that which his great and wife Creator has already form'd in his Body; and if he would but take the Pains of confulting the greateft Mathematicians on this Occafion (Borelli for Inftance, Sect. IX.) he will foon find how readily they acknowledge herein the Wifdom of the Creator. Wherefore, in Cafe he be not convinced by all this, but continue to think that fuch a Structure, which camnot be mended, neither by his own, nor by the Skill of all the Men in the World befides, in order to be made fublervient to thefe Purpofes, hâs yet acquir'd its Exiftence by meer Chance; to what fhall we afcribe the Caufe of fuch defperate Notions, but either to his Ignorance, which fuffers him not to underfand thefe Things; or toa fecret and dreadful Judgment, proceeding from L4 perferere in this miferable and fatal Darknefs. Bura to proceed.

## S $\equiv \mathrm{c}$. . 1X. The InJertian of the Tendons.

Suppose A B, and F G, in Tiab. V. Fig. 6. tq be two Bones joyned together, which make a Joint at A F; now if one would bend the Bone A B, at H, and for that purpofe, only matie ufe of the Draught and Coatraction of the Mufcle D R E, which is imnoreably faftern'd to $D$ in the fame manner as one mores the loweft Bone of the Arm, by bending it in the Joint of the Elbow towards the uppermolt Bone or Os Humeri: Let us fuppoie firlt, that the Tendon of this Mufcle is inferted at E, orclore to the Hand in the extream Part of the Bone A B, we may then eafily bend thefe two Bones upon contracting the Mufcle 1 ) E, at the Joint A F: But if the Bone A B, be brought to h H , in fuch cafe the Muicle D E muft be contracted or Gorten'd to M D; but if one proceed farther, in order to caufe the Part H to approach yet nearer to D , by the fame Mufcle, the whole Mufle DE, which is now froten'd to D M, will ina Manner lofe irs Length, and be rolled up in a Ball or giobular Figure at the Shouldor D: Befides that when the Bone A B is is taifed up to AH , the Skin muft have fo much Space or Room as to corer the whole Triangle A H D, unlefs the Murcle were alled and loofe from tike Arm, as is repreferted in this Figure,

Now ifthis fhould happen in many Parts of the Body, and that more room frould be taten up in the Skin, by other Mufceles that are larger, and planted in the Borte after the fame manner; and to make larger Balls o: Spherica! Figures in the

## The Cariftian Pbilofopher.

Places where, by their Contraction, they are rolled up together, the Body would lofe its Figure at every Motion by fuch Expanfion of the Skin, and upon the ceafing thereof and Extenfion of the Mufcles lengthwife again, the Confequence would be, that the expanded Skin would hang upon the Body like a Bag full of Pleats or Wrinkles, to the end that it might have room enough in its fubfequent Motions.
'Tis true, that it feems as if this manner of Infertion might have been paffed by, to preferve the beautiful and noble Structure of a humane Body, and a Band or Ligament placed at R, to obviate the receding of the Mufcle from the Bone: So that the Body of the Mufcle it felf being then extended no farther than to D R, a long Tendon ER, need only be fretched to E, and likewife faften'd to the Joint at its Inflection by the Ligament R, as is frewn to happen in Tab. V. Fig. 4. where there was a particular occafion forit, name1y, that the Hand might not be burdened with toa much Fleff.

But in fuch a cafe, it cannot alfo be denied, that if all the Tendons were faften'd to the extream Part E, of the Bone A B (Tab. V. Fig. 6.) notwithftanding that they were kept down by the Li gament $R$, yet, by reafon of their Length, they would fill a much greater Part of the Body, and take up more room than they now do, which would not only be unneceflary, but would likewife difplace fome other Part.

Not to mention that in this Strucqure the Tendon RE, running either parallel with both the Bones, G F and A B, or making a very fmall and acute Angle at E, with the Bone AB as long as the Angle remains fo fmall, could not be able to exert much Force in order to raife the Bone, tho' drawn with great Violence. That it falls out

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With how much more Advantage than has the great Creator of Mankind been pleafed to direct this Infertion of the Tendons in the Bones, after fo wife a Manner, that not only all thefe Inconveniencies are thereby prevented, but likewife the Spaces, which would be otherwife filled ty the exceffive Lengths of fo greatly extended Tendons, may with much Eare be employed in receiving otherParts that ferve for farther Purpofes?

For this End it has pleafed him in his Wifdom to place little Eminences at the extream Parts of the Bones, and thereby to render them thicker and ftronger in that Part, and to infert the Tendons near or in the faid Eminences, or clofe to the Joints in the following Manner

Let A. B and F G (Tab. V. Fig. 8.) be two Bones, making together a Joint at A.F G, which is moveable at the Point C, fo that both of 'em at their Extremities IK A F are globular, and thicker than their Tubes: Now the Mufcle D E K I is inferted at I , clofe to the biggeft K nob of the Bone B A; fo that it runs about the Emincncy K I, likic a Rope in a Pulley, if we may be allowed to give fuch a courfe Idea of it.

## Sect. X. This Infertion of the Tendons prevents all

 Inconveniencies.We need not then take much Pains to thew, that by fuch a Method all the aforementioned Inconveniencies are removed; forafmuch as, Firft the Tendon being inferted at C (Tab. V. Fig. 6.) and not at $E$, when contracted towards $D$, cannot make fuch a Triangle as M C D, and confequently don't ftand in need of fo much Room in the Skin for its Motion. Secondly, the Mufcle D E K I (Tab. V. Fig. 8.) being inferted in or near the Thicknefs of the Bone, in order to produce a great Velocity at $B$, the extream Part of the Bone A B, fuch as from B to $M$; it needs only inflect the Point $I$, in a very fort Segment of a Circle to K ; for which Reafon likewife the Mufcle requires very fmall Contraction; nor is it requifite that the whole Length fhould be rolled up in a globular Figure : and thus, the Mufcle being grown but very little thicker by fo fmall a Contraction, the Body lofes nothing of its Figure and Beauty; whereas otherwife, if the Tendon were inferted in the extream Part of the Bone (as at E, Tab. V. Fig.6.) the faid Body, fuppofing the fame fhould happen in all its Parts, would for both thefe Reafons become very monftrous. Thirdly, We may likewife fee here, that the whole Length (Tab. V. Fig. 8.) remains free from I to $B$, without being filled by the Tendon of this Mufcle DEKI, and fo there is a Place left for other Parts and orher Ufes. Fourthly, The Mathematicians know, that when the Mufcle at K, fix'd to the Knob or Thicknefs of the Bone FAI K, performs its Function after the manner of a Puiley; the Line K C, which extends itfelf from the Centre C to K, on account of the Roundnefs of the faid Knob, is always nearly of an equal Length ; and therefore when the Mufcie is contracted

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$\mathrm{t}_{\text {racted }}$ with equal Force, it always exerts the fame Strength when it proceeds to lift up the Bone AB; in which, it has been already fhewn, at $\mathcal{T} a b . V, V I$, VII,there would have been a great Inequality on account of the changing the Obliquity of the Angles, had it not been for this manner of Infertion.
SECT. XI. A Mufcle exerts a greater Force againft a Smaller Wight.
It is true that the Mufcle DK (Tab. V. Fig. 8.) acting on a fhorter Arm of a Leaver C K, and an oppoliteWeight at a longer Arm C B, the P wer of the Mufcle muft be fo much greater than that of the Weight ; and that it feems to contradiet the Cuftom of Men, in making Inftruments to raife up 2 greater with a fmaller Force, fince all theit late Difcoveries in Mechanicks, in the feveral Engines for Motion, fuch as Balances, Leavers, Pullies, Wheels, inclin'd Plains, and Screws, ©c. feem to have a contrary View, that is to fay, by a fimaller Power to move a greater Weight; which Weight they therefore hang upon the fhorteft Arm.

But no Body will be able to deny, Einf, That in the Motion of the Mufcies, all the Inconveniencies already enumerated, are avoided by this Difpofition, which requires a greater Force in the Mufcles.

Secondly, That in the common Mechanical Infruments, where a greater Weight is raifed by a fmaller Power or Force, the Motion of the Weight is always much flower than that of the Power; and that if it be required to raife the fame Weight with greater Velocity or Quicknefs the readieft Way ; the Power muft be apply'd to the fhorter Arm, and the fame proportionably, encreafed in Greatnefs only, without being oblig'd fcarcely to augment the Velocity thereot in this Cafe, which would otherwife be neceflary. UJe of by the Mufcles againft a fmaller Weight.
$I_{\text {F }}$ this Matter does not appear yet clear enough to every one, let them imagine that the Mufcle DK I (Tab. V. Fig. 8.) does by its Force move the Knob of the Bone KIAF from $V$ to $K$, by which Means the Point B is at the fame Time raifed to M , and therefore acquires fo much more Velocity than the Point $V$ or $I$, upon which the Force of the Mufcle operates, as the Arc B M; or the Arm BC, is fo many Times longer than the $\operatorname{ArcK~V,~or~the~Arm~K~C~;~and~therefore,~}$ the Mufcle itfelf will be but a very little contracted, as it is plain to every one that confiders this Matter.
$S_{E C T}$. XIII. Convictions from the foregoing Obfervations.
Now can any Body that judges impartially forbear obferving here, that the great Force of the Mufeles which is required in exerting their Motions in the abovementioned manner, is fo far from a Diminution of the Wifdom of the Creator, that, on the contrary, it ought to be an Occafion of Thankfulnefs to every reafonable Perfon; forafmuch as their gracious Creator has been pleafed, in augmenting the Force of the Mufcles, to caufe them to operate in fo eafy and almoft infenfible a Manner, with fuch little Contractions, and yet at the fame Time tomake them produce the Motions of the Limbs upon which they aet, with fuch an unequaly greater Swiftnefs?

And can any unhappy Atheift pretend, that he fees neither Wifdom nor Goodnefs in all this ? And will he yet afcribe it to ignorant or accidental Caufes? Every Body that judges impartially, mult undoubtedly think him very malicious, or fark blind
blind. Muchmore muft an inconftant and wavering Mind be irrefragably convinced hereby ; not only that a wife Contrivance of a Workman is requifite for thefe Purpofes: But even that a great Power, yea, a divine Power, furpaffing all that is $t$ humane, flines out here with the utmoft Luftre.

Sect. XIV. The very great Strength of the $M u \int_{\text {cles. }}$
Ask an Atheif, ask a Sceptick, ask ${ }^{\text {a }}$ great Mathematician and Philofopher, ask all Men without Diftinction, and let them fay if they can, after what manner in fuch tender Threads of Mufcles, as are thofe of which the Flefh of Men and Beafts is made up, a Faculty is lodged, by which, upon their contraeting themfelves, fuch a furprifing Force can be produced, as is exerted by them in their Motion.

And let no Body think that we are feeaking hyperbolically to magnify the Matter, or to excite their Aftonifment: For,

Fir $f$, Can any one believe, if it had not been demonftrated by that great Mathematician Borelii, Par. 87, 88, and 127 , that when a Man lifts up with his Mouth a Weight of near two hundred Pound with a Rope faften'd to the Jaw-Teeth (which, according to him, has been done even as far as to three hundred Weight) that the Mufcles named the Temporalis and the Mafeter, with which People chew, and which perform this Work, do exert a Force of above 15000 Pound Weight ?

Secondly, Can any one fee without Aftonifhment, that when the Weight R (Tab. V. Fig. 9.) of fifty five Pound is held up in Equilibrio by the Elbow B, of the Arm AB, the Mufcle named Deltoides DC, which only raifes the Arm in this Pofition, exerts a Force of above 60000 Pound ? See the faid Borelli, Par. 124, at the End.

Thirdly, If any one hanging his Arm directly downwards, lifts a Weight of twenty Pound, with the third or laft Joint of his Thumb, can he learn without Amazement, that the Mufcle which bends the Thumb, and bears that Weight, ufes a Force of about 3000 Pound? He that doubts of it, may confult the abovementioned Borelli, Par. 86, 126.

But, Fourtbly, He who fees that the Mufculi Glutai, which together compofe the greatef Part of the Buttock, and move the fame about the Top of the Hip-bone backwards, do exert a Force of about 300,000 Pound, when they raife a Weight of 65 Pounds, by extending horizontally the Bones of the Leg and Thigh, according to the Experiment of Borelli, Par. 125. I fay once again, Whoever fees and undertands this, muft needs admire the Power of his great Creator, that he has endow'd our Mufcles with.fo vaft a Strength. See Borelli, Par. 125.

Efpecially, if we here add, Fifthly, That calculating all the Forces of the Mufcles that are exerted, when a Man, ftanding upon his Feet, does only leap or fpring upwards the Height of about two Foot; if the Weight of fuch a Man be a hundred and fifty Pound, the Mufcles in that Action will exert above 2000 Times more Force, that is to fay, about 300000 Pounds. Borelli, par. 176, computes it yet higher.

And, Sixtbly, That the Heart at each Pulfe or Contraction, by which it protrudes the Blood out of the Arteries into the Veins, exerts a Force of above 100,000 Pounds; fee the fame Borelli, Par. 76. p. Ir we chufe rather to fpeak of thefe Matters in round Numbers, than exactly to follow his Calculations, (which are every where larger) that we may prevent any Cavilling in thefe furprifing nd wonderful Matters.

## $\mathrm{S}_{\mathrm{ECT}}$. XV. Convitions from the foregoing Objer

 vations$\mathrm{Y}_{\mathrm{EA}}$, if the Force of the Mufcles were really much fmaller, ought we not to ftand amaz'd at it, whilf we thus difcover in our Bodies the Divine Power of our Creator, producing fuch ftrange Effects with a Matter fo fine and tender as the Flefh of an Animal, contriving and difpofing them in fo narrow a Compafs, and adapting' em to fuch regular Ends? When we fee the Joints form'd, and their Motions maintain'd by perpetual Fountains of Oyl and Water (of which more hereafter) to preferve them fmooth and fupple? And above all, when we fee fuch furprifing Force in many Mufcles fo readily obeying his Will, that istofay, moving and refting as we pleafe; and others again, moving fontaneoully and involuntarily; and farther, a Faculty or Power placed in the Mufcles themfelves, whereby, tho' their Motion ceafes, they are contracted or fhorten'd; and this Power balanced by a contrary or oppofite one, in fuch a Manner, that the Parts of the Body may alfo keep their jull Proportions, without any Concurrence on out Side; as, for Inftance, the Mouth is preferv'd and held exactly In the middle of the Face, by two Mufcles drawing againf, and balancing each o ther; this is very obvious, when one of thofe Mufcles having loft its Force by any Difeafe, the other fhall convulfe or draw the Mouth awry, and thereby the Face will be depriv'd of its beautiful Regularity and Uniformity.

To conclude this whole Matter, Can any ore afcribe all this to Chance, or one that works without knowing that he makes any Thing, and this in particular? And does not this prodigious Force which the Mufcles exert, raife his Thoughts to an Almighty Workman; and the Direction of them,

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0 infinite Wifdom and Goodnefs? And can he blecre, that almolt inexpreffible Force, which his 3ody would exert, if all the Mufcles thereof fhould ut forth all their Strength at once, without being truct with Amazement at the fame.
He that cannot yet, in the Contemplation of his ,wn Body, difcover a God, how unhappy, how eplorable, muft he be?

Ect. XVI. Iranfition to the Demoinfration of the Furce of the Mufcles.

Whilst I am writing this, it is objected to ie by a certain learned Perfon, that what has been id about the Force of the Mufces, will not apear to all Readers fo ftrange as really incredible; nce it will not eafily be admitted by any one ithout further Proof, that a Power of fo many aoufand, yea, hurdreds of thoufand Pounds, in be exerted by the Flefh of a human Body: Therefore that we may not give Occafion to $A$ eiffs and Scepticks to think that we rather affect to y lomething here that is furprizing and uncomion, than what is true ; it feem'd neceffary to fhew fome manner, the Grounds of our Affertions: He wn'd indeed, that I had referr'd thofe who doubt1, to Borelli and his learned Work, but that the me could not well be read and underftood, but by perienced Mathematicians; but forafmuch as all them did not entirely agree in their Inveltigatiis of Nature, the unhappy Philofophers whom e endeavour to confute, might pretend from thence , avoid the Force of this plain Proof of a great, owerful, wife, and gracions God.
For which Reafon, he added, if it could conveently be brought about, it would be of great Ufe , demonitrate this Force of the Mufcles, which , far furpafies all Belief, upon fuch Grounds as Vol. 1.
mighe eafily be apprehended by a fenfible Reade r: tho' not well verft in Mathematical Sciences.

This Confideration has prevail'd on me to infert here the following fhort Digreffion, which may help to give thofe that are unexperienced, a clearer Conception of what Borelli has difeover'd 10 this, Matter, in which I have therefore repefented the greatnefs of the Force of the Mufcles as plain as $]$ can, without adding thofe Mathematical Demonfrations, which are fo tedious to fome, and fo unin. teiligible to others; requiring nothing more of our Reader, but that, befides the Knowledge of a few and commonMechanicalInftruments, he underfands never fo little the Ufe of the Tables of Sines, and the Computation of plain Rectangular Triangles, which may be learn'd by any reafonable Perfon, if he be rightly inftucted, in a Week or léfs; in cafe he thirks this great and convincing Proof, of the Perfections of his Creator, deferves fach Pains: However, if there be any who have no Inclination this way, they may pafs by thefe Demonftrations, and proceed to the following Matters.

## Sect. XVII. Brief Demonftration of the Force o, the Mufcles.

1. OW to reprefent to an ordinary Capacity, and convey, in fome meafure, to the meaneft Underftanding a clear and diftinct Notior of the great Force of a Mufcle, as it were by Gra. dations : Let us fuppofe (Tab. VI. Fig. 5.) that the Mulcle, K D QP, is the Deltoides; of which mention has been made above (5. 14.) whofe Of fice is to lift up the Elbow.
2. This, according to Borelli, ( $\$ .82$.) is a Radius Mufcle, compofed of feveral Plum iformar Muf. cles, like $H Z Q L$, and $G V P$ W. See below ist
3. Let us here, for Plaimefs and Conveniency fake, imagine this Mufcie to conlift only of theti
two p'umiformar Mufeles, viz. H Z Q L, and G V P W.
4. How this Force will be calculated, when the Mufcie is compos'd of more plumiformar Mufcles than two, will be made appeat hereafter.
5. Thefe Mufeles are callod Plumiformar ; becaufe that in GVP W, the moveable Tendort, D G P has inferted into it, on both Sides, a great Number of carnous Fibres, as G V P W, all which like the fingle Feathers of a $Q$ iil, run paratiel to each other, and are faften'd to the oppofite Tendon V P W, which being immoveable, cannot follow.
6. Seeing therefore, thefe carnous Fibres, G V and $G W$, are bo.h of them fant and immoveable at VW ; and feeing, that each of them is to be contracted by a Power, be it what it will; the Confegience mult be, that of Neceffity they are to be crawn upwards, together, from G to N .
7. After the fame manner, likewife, the Point H is drawn up to O, in the other plumiformar Mufcie, $H$ Z Q L, by the Contraction of all the late* ral Fibres, as HZ and HL.
8. We fee, that the Points H G, or rather the Tendons, DH and D G, being lifted up to O and N ; the Point D , and therewith the Tendon K D , muft neceffarily follow directly, and be drawn up, in a right Line, to X .
9. If the Forces, which draw the Points H and G upwards to Q and P, be equal, the Obliquities or Angles, $H D X$ and $G D X$, mult certainly be equal alfo; then taking this for granted, as we fuppofe it is; it follows, that there will be an E quality in the mufcular Fibres, aforementioned, not only as to their Obliquities or Angles, N G M, NGR and OHL; OHZ, which thefe, and all the other Fibres form with there moveable Tendons, $H Q$ and and G P; but chere will alfo be an Equlity to their Forces.
ro. Thefe Angles H D X and G D X; as alca V G N and W G N, and in the other Mufcle $\mathrm{Z}_{\mathrm{HOO}}$ and LHO (which form the Directions of the obliquely drawing Forces D G or DH with the Diretion of the perpendicularly drawing Force, D X ; and of the mulcular Fibres, G V, we G W , or $\mathrm{HZ}, \mathrm{H}$ L with their moveable Tendons, fhallhereafter, forBrevity fake, call Angles of Obliquity
10. To proceed; let B be the Elbow upor which the Weight $\mathbf{T}$, hangs ; let B I A be the up per Bone of the Arm or Humerus; let K EFA be the round Bone thereof, which can turn in the C : vity E F, in the Shoulder, about the Center C and lafly, let the Tendon D K I, which is infert ed in the Bone at I , touch the round Bone at K at the Extremity of it.
11. Thus it muft appear to every one, tha when the Tendon D K I (8) is drawn up to X according to the Line K X, the whole Bone I B A will turn about the Center C ; and K will be mo ved to $n$, and $B$ to $m$; 'tis plain the Weight T, by the contracting Power of the two plumiforma Mufces, muft thus be lifted up.
${ }^{13}$. This therefore is a flort Defcription of the Action of the Mufcle Deltoides, when it lifts ut the Weight Thanging upon the Elbow B ; or ra ther poifing it in Equilibro.

1 4. To enquire further into the Force of thi Mufcle, let us begin from the Weight $T$, and pro ceed upwards to the Murcle.
15. This Weight T, according to the Obferva tion of Borelli, ( $(.84$ ) is found to be 55 Pounds. which (the Weight of the Arm be'ng included) is what being hung at the Elbow may tolerably b fupported.
16. Since the Weight $T$ draws the Bone of th Arm B A I downiwards; and the Tendon IK D draws the fame upwards, by the Force of th Murcie D QF.
17. It is eafy to perceive (and is what has been obferved before) that thefe two Powers here do reffit each other, like the Steelyard, or angular Balance, BCK.
18. We likewife fee that the Arms of this Balance, BC and K C , are of very unequal Lengths.
19. Now every Body knows that a Weight, fuch as $t$ here, drawing with a Chord $\operatorname{tr} \mathrm{DK}$, the fiorteft Brachium or Arm, C K, muft be much greater than the Weight $T$, which hangs at the longeft Arm, C B, to caufe them to balance one another.

And therefore we fee, by thefe unequul Brachia, BCK, that the Force of the Mufcle DQP, which draws the Arm K C, inftead of the Weight $t$, muft be greater than the Gravity of the Weight T, or 55 Pounds.
21. To proceed, then, to fhew how much the Force of this Mufcle muft be greater than the Weight T : It is a known Rule in Mechanics, that if the Weights $\mathbf{T}$ and $t$, are faften'd to a Balance of unequal Arms turning at C (which either hang ftreight down, as in Tab. VI. Fig. 2 ; or makes an Angle at C, as in Tab. VI. Fig. 3.) each of them drawing at right Angles at K and B , the refpective Arms of the Balance, the Weight $t$, hanging at the fhorteft Arm K C, muft be, in order to make an Equilibrum, fo many times greater than the Weight T at the longeft Arm; as the longeft Arm, B C, is longer than the fhortef Arm, K C.
22. Every one that doubts of this, may from Experience be convinced, by making fuch Balances or Steelyards, which may be affected, by bringing the Gravity of the Arm it felf, in fuch a Potition with the Weight, as Mathematically to obferve an Equilibrium therein.
23. Now, granting the Rule (21) to be true, as it apparently proves to be; Borelli finds ( $\$ .8_{+}$) M 3

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by exact Scritiny, that the Length of the Elbow BC, ('Tab. VI. Fig. I.) from B, where the Weight T is lufiended to C , the middie of trie round Bone or Joint (which Lengtia $B C$, makes the loreft Arm of the Balance) is fourteen Times as long as K C, the half Thichnefs of the faid round Bone KEF A; the Semidiamiter of which makes the Shorteft Arm of the Balance.
24. For which Reafon then, according to the forefaid Rule (21) the Tendon K D, drawing from the Ghorteft Arm K C, ought to have fourteen Times the Force of the Weight T, in order to redice the whole to an Equilibrium.

Now this Weight T , according to (15) the Obfervation of Borelli, is 55 Pounds: So then the Force, wherewith the Tendon K D muft be drawn up by the Mufcle, or by the Weight, in order to maintain the faid Equilibriwm, is equal to 14 Timés 55, or to 770 Pounds.
25. And thus we fee how much the Force, which the Mufcle D QP exterts, muft over-balance the Weight $T$, which it raifes up only from the Head of the Steelyard BC K; becaufe it draws the fhorteft Arm K C.
26. For Inftance, imagine the Tendon K D continued tor; and further, fuppofe the Weight $t$, hanging perpendicularly from the Pulley at $r$, and fo faftend to the Tendon K D, that the Pulley may play (or run round) ; 'tis manifeft, that the Weight $t$ muft amomnt to 770 Pounds, if it poifes the Weight T, or makes an Equilibrium with it.
27. But now if this Force of 770 Pounds were to be produced by two other Forces operating obliquely, according to D G and DH (inftead of the Weight $t$, whole Power is directed by the ftraitLine K Dr) we fhould perceive this Motion to be, according to what the two plumiformar

Mufcles, H Z Q L and G V P W, muft neceffaily be apprehended, by their moveable Tendoris, D Q and D P, to produce.
28. It is then plain, that each of thefe two p'uniformar Muifcles, HZ QL and GVP W, muft aife the half of 770 or 385 Pounds; it being graned, that the Forces, as well as the Angles of Obliruity HDX and GDX (10) of each plumifornar Mufcle, are equal to one another.
29. There does theretore occur in this mufcular ieructure another Machine, or rather a Pulley, rhereby we may learn, that the plumiformar vufcles will each of them exert a greater Force han 385 Pounds, or 770 Pounds together ; and his Augmentation of their Force is owing to the Alteration of the Line of Direction of the Power which here draws, by thefe two Mufcles obiquely; leviating, at the fame Time, from the direct Line D Hr, and forming the Angles K D G and 5 D H.
30. To prove this, fuppofe (Tab. VI. Fig. 4.) a Veight K, of 770 Pounds, hanging at a Cord, Z $\mathrm{D} r$, which turning over a Puiley $r$, has as its , ther End, another equal Weight $t$, viz. of 770 ?ounds capable of fupporting the firft Weight K.
31. Now let it be imagined, that this Weight $t$ s taken quite away; but to fupply its Place, two , ther Weights ate fribftituted, viz P and Q ; the Chords of which Weights, viz $\mathrm{P} n \mathrm{D}$ and Q 6 D , un about the Pulies $n$ and $b$; and both are fater.'d to the Rope X D at D; and from the Anels $n \mathrm{DX}$ and 6 DX .
32. It is plam, that if the Weights P and Q be qually hary, and the A:gels of their Obliguity (10) 3 D X and 6 D X , be equal, each of them muft aife the half of the Weignt K , which is compuexi to be 770 Pounds, that is to fay, each muf? taife 315 Pomends.
33. This is what is obferv'd before in the Cafe of the two plumiformar Mufcles, Z QL, and V P W, (28) with no other Difference than here, inftead of the two plumiformar Mufcles, two Weights, $P$ and $Q$ are fubftituted, to render the Demonftration more intelligible.
34. But here occurs another notable and known Truth in Mechanicks : If two equal Weights, P and Q, do hold in Equilibrium a third Weight K, with the Apparatus of Cords reprefented here, in Tab. VI. Fig. 4. and defcribed (3I) each of thole two Weights, $P$ and $Q$, mult be fo many Times heavier than the half of K (or 385 Pounds) as the Line D G is longer than D X.
35. Obferving at the fame Time, that the Ratio (or apparent Length with Refpect to each other, of the Lines D G ard D X, are found by taking an libitum, a Point, as X , in the extended Line K D. and from thence drawing the pricked Line $\mathbf{X}$ G; fo as to make the right Angle G X D.
36. To know then how many Times the Weight $P$ and $Q$ are each of them greater than the half o K , or $3^{85}$ Pounds, we need oniy enquire how ma. ny Times D G is longer than $\mathbf{D}$ X.
37. And this is found by knowing the Chord o the Angle of Obliquity, G 1) X (or the Number o Degrees fubtended by a Line falling at right An gles at X, and cutting Part of the Arc of the Circle at the Points $X$ or $G$, the Centre of which Cir cle is to be at D): Therefore, having found the Angel G DX, the Angle DGX is knowno Courfe; becaufe the whole Triangle being rectan gular, the two Angels G DX and D GX, mul be equal to one right Angle, or the Angle D G X
38. After which (35) drawing a Line at Plea fure $d x$ (Tab. VI. Fig. 5.) and fo as it may be di vided into 385 Parts, by a Pair of Compaffes, ant drawing fromit at $x$ another Line $x m$, which malie
the right Angle $d x m$, and drawing from $d$ another Line, $a n$, which muft cut $x m$ at $g$, and form with $x d$ the known Angle of Obliquity $x d g$.
39. Then if we meafure the Line $d g$ with the Compaffes, and obferve how many fuch Pares (of which 385 make up the Line $d x$ in this Infance) are contained in the faid Line $d g$, we fhall find, in this Cafe, the Parts of $d g$ to amount to about $44^{2}, 4$. Whereby it will be known that $d x$, in Fig. 5. or D X in Fig. 4. Is to dg, or D.G:: As 385 : To $44^{2}$.

And according to the Rule (34) that the Weight P or $Q$, will each of them amount to $44^{2}$ Pounds, and confequently fo far exceed the half of K , being 385 Pounds: By this way, even thofe who do not underfand Mathematicks, may be made to apprehend thefe Demonfrations.
41. But they who have made the leaft Progrefs in that Science, and are but tolerably verfed in the Calculations of plain Trigonometry, may, without this round-about Way of Admeafurement, or making the new right angled Triangle $d x g$, (Tab. VI. Fig. 5 have Recourfe to the Tables of Sines, Secants, and Tangents, with the fame Eafe as if the Line D X (Fig.4.) were really divided into 10,000,000 of Parts; or, if fo much Exactnefs be not required, into any lefs Number.
42. For if you fearch thofe Tables for the fecant Line of fuch a Number of Degrees as the Oblique Angle G D X contains, you have exactly the conftituent Number of Parts of the Line D G.
43. And comparing the fe 10000,000 Parts, with the Number found in the Secant correfponding, you will have the Proportion of D X to D G; or know how many times D G exceeds D X in Number of Parts; and confequently how much heavier the Weight $P$ is than the half of the Weight $K$.

There
44. That as the Radius, or $10.000,000: \mathrm{Ta}$ the Secant of the Angle of Obliquity G D X : : So is DX: To D G; or (36) the half of the Weight K , to the Weight P .
45. Now to bring thishome to our Cafe, Borelli finds ( $(\$ .82$.) that the Obiquities of the Tendons DG and HD(Tab. VI. Fig. r.) upon the Tendon K D X, viz. the Angles X D G and X D H, are equal, each, to 30 Degrees; and the Secant of 30 Degrees, as appears by the faid Tables, is $11.547,005$.
46. Now fince an Inconveniency attends the Greatrefs of thefe Numbers; and fince the Calculation here before us does not feem to require fo great Exactnefs, the Proportions may be fufficiently expreffed, tho' as many Letters, or Cyphers be cut cff from each of thefeNumbers (viz. $100.000,00$ and II. 5470,05 ) as fhall be thought convemient; that if from each five Figures or Cypher be laid afide, the remaining Proportion, 100 and 115 , will exprefs this Matter clearly enongh: Therefore, if D X were to be divided into 100 Parts, D G would as much exceed D X as 115 exceeds 100 .
47. Suppofing the Cafe to fland thus: There 100 Parts (or the Radius) according to (34): Are to 115, or the Secant of 30 Degrees (or 1 X to G D) :: As 385 Pounds, or the Half of the petpendicular Weight K: To 442 Pounds, or the 0 blique fu.fended We:ght P (Tab. VI. Fig. 4.)

Which is in brief thus; D $\mathrm{X}: \mathrm{GD}::-\mathrm{P}$, or
the fame in Numbers; $100: 115:: 385:{ }^{2} \not \psi^{2}$.
48. Now this Weight P, reptefonts the Force of the plumiformar Mulcle, G V P W (Tab VI. Fig. I.) which therefore in this Cafe muft be +4.2 Pomas.
49. And

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49. And the we fee how the mufcular Force, whicin was augnented before ( 24 and 25 ) by the floftels of the Am of the Steelyard, is here yet more ..ginen wa by the Obliquity of this Dranght tendrijg towards DP ; namely, from 385 to 442 Poinds.
50. So that in cafe the Tendon DP, were lengthend tos, and moved about a Pulley there, a Weight $q$, mu A be fufpended to it there; and likewite one of the fame bignefs muft draw the Tendon D Q, to the Lind, that by making together 884 Pounds, they may raife directly, or perpendicularly, the Tendion DK, by their oblique Diaught; whofe Force, according to the Direction D X, is equal ouly, to 770 Pounds.
51. But if, farther, we fhou'd again remove the Weight $q$, as before, and raife the Tendon D G, according to the Dirction DP , with the fame Force of $44^{2}$ Pounds, by the Help of the two obliqueiy acting Powers, according to G V and GW.
52. The fame Machines or Pullies occur here as before ( 29, cic.) (Tab. VI. Fig.4.) and the fame Properties in all Points.
53. And it follows ( 32 and 33 ) that the Powers S V and G W, acting accordingly (Tab.VI. Fig. ı.) each will raife to the half of 442 , or 221 Pounds.
54. As alfo, that the Force G W, in order to operate as aforefaid, muft be as many times greater than 221 Pounds, or the half of the Weight $q$; as $G W$ is longer than $G S$; fuppofing again (35) that G S W is a Right Angle.
55. Tine Proportions of both which, G S and G W, are found, if the Angle of Obliquity S GW be, moreover, known; after the fame manner as we have fhewn above (from Propofition 35 to 44.)
56. That is (by the Rule 44) As the Radius, or $1000,000:$ Is to the Secant of the Angle of Obliquity S GW (or by 34 ): : So is the Half of 242 or 22 I Pounds;

Pounds : To the Force that mult act according to GW.
57. Now, in order to difcover the Power of this laft Force, Borelli finds ( $\$ .82$, ) that the Angle of Obliquity, S G W, made by the contracting of the carnous Fibres G W, with their moveable Tendon GP, is an Angle of 8 Digrees; the Secant of which (Itriking of the two latt Cyphers) a ppears by the Tables to be 100,982:58.
58. And confequently according to 47 .

As 100,020, or the Radius: To the Secant of 8 Degrees, or 100,982 :: So is the Force of 221 Founds drawing directly : To 223 Pounds; or the Force which draws obliquely, according to G W, when it raifes the faid 221 Pounds perpendicularly, according to the DireEtion GS.

Which in fhort ftands thus;

$$
100000: 100982:: 225: 223 .
$$

59. So then the carnous Fibre GW, exerts a Force of 223 Pounds in this Cafe when it operates fingly; and when the plumiformar Mufcel, G V P W, has no more than this only moveable Fibre, G W, onf this fide.
60. We will fuppofe it to be really fo, in order to render it more intelligible to unexperienc'd Perfons; and afterwards briefly fhew, how it wou'd be, in cafe there were in each half GPW, of the plumiformar Mufcle, as many more Fibres as may be imagined.
61. In the mean while, fince according to this Suppofition there are two plumiformar Mufcles, as GVP W and HZ QL, of which this great Mufcle, or Deltoides, is compofed ; and fince each plumiformar Mufcle has two Sides, each of which (59) exerts a feparate Force of 223 Pounds, and joyntly a Force of 446 Pounds; this then is the Force of the whole phiniformar Mufele, G VP W.
62. That
63. Thus we fee that this whole Deltoider, confrfting of two plumiformar Mufcles, or four half Sides thereof, by the Force of the Steelyard BC K (25) dees balance, by the firlt oblique Draught of the mufcular Fibres, G V, GW and H Z, HL, a Force, or Weight, four timés 223 Pounds, or 892 Pounds.

So, that inftead of the Force of each carnous Fibre, G W, ©rc. there hung, fufpended, a Weight $p_{3}$ of 223 Pounds each; four fuch Weights muft operate with the fame Force, as the four Sides of the two plumiformar Mufcles; and thereby the Weight $T$, hanging to the Elbow $B$, wou'd be kept in Equilibrium.
63. Now to pafs on, further, to a greater Augmentation of the Force of the Mufcles, produced by the the Structure of carnous Fibres, GV, GW, Z H, HL, $\delta c$. which are moveable ; and allo produced by the Texture of the Mufcles themfelves.
64. We find, after the niceft Scrutiny, that there mufcular Fibres W G (Tab. VI. Fig. i.) have of feveral little, hollow Interftices; which, whilf the Fibres are extended lengthwife, as A B C DE (Tab. VI. Fig. r.) are included within right Lines; but when the Power which extended thefe Fibres ceafes, thefe Interfices appear in circular Figures, as wo, ©́c. (or G M W, Tab. VI. Fig. ..)
65. If now, by the Fibre W G, being immoveable at $G$, a Weight $T$, fufpended to it, mult be raifed 'tis plain, that in performing fuch an Action, by any Force (whatever it be) the Breadth or Thicknefs of the faid Fibre mult be imagined to be encreafed; and the Length, at the fame time, mult neceffarily be diminifhed.

So that the Parts A B CDE (Fig. I. Tab. VII.) being dilated, or made wider, do affume the Figures $a b c d e$; by which the Length of the Fibres W G, becomes vifibly thortned ; viz. from W G to $w g$; and the Weight $T$, at the fame time, is rais'd up to $t$.

66 This

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66. This Tum: faction, or Swelling of the Fibres, which compofe the Body of the Mulcle, cioes palpably appear in feveral Parts of our Bodies; and in feveral particular Mufci:s, which contract themfelves in the Exercife of their proper Functions.

Let any Man, with either Hand, take hold of his other Arm juft below the Elbow, to convince himfelf, whether or no he does not feel the Mufcies of the Arm fwelling and contracting themfelves, when he opens and fhuts theFingers of the Hand which he fqueezes that way below the Elbow. -
67. Now whether the Eigure of thefe long Pariicles, or little Tubes A B C DE (Tab. VII. Fig. r.) be round, as $a b c d e$; or whether they may be imagined Square, as $a b c d e$, the better to determine their Co-operation with other Fibres, we fhall not pretend here to decide ; it being a Matter foreign to our prefent Purpofe.
68. Neither do we here enquire after what manner, or by what Caufes the Interftices A B $\subset, \sigma c$. become thicker, or how they allume the Form of $a b c$, óc.; concerning whieh, we leave every Man to enjoy his own Opinion, till the trae and certain Manner thereof be clearly and inconteftably demon!trated.
69. This is certain, that each carnous Fibre, as W G, confifts of a multitude of little Inftruments, as ABCDE, each of which do become thicker and fhorter in Motion.
70. The Truth of the laftappears experimentally from above (66) ; it remains therefore to thew the fe little Inftrument, $a, b, c, d, e, f$, © $c$. (Tab. VII. Fig. 2.) in each Thread, $a p$, where a Contraction happens (and confequenty the Breadth muft be augmented) are very many in Number, and the Minutenefs of each exceeding fine.
71. Let us fuppofe, in TTab. VII. Fiz. 3. a e to be a Fibre with Intertices; which, in its
utmoft Extenfion, reachesto $e$, or is of the Length $e e$; at the Tendon whereof a Weight $q$, being lufpe ded, it is held in an Equilibrium ; but as foon as a e is contracied ro $a d$, the Weight $q$ is raifed to P .
72. Imagining this Fibre $a$ e, to confint but of one Machine, viz. abcd, it wou'd be able to rife the Weight $q$ up to $P$; becaufe theLine ae wou'd even by this means be contracted to a d
73. But that this will not anfwer the Motion of mulcular Fibres, which we are here accounting for, appears;

Firft, Becaufe when the Machine a $e$ is fo long, the Thicknefs $b c$, would be incomparably greater than we now perceive in contracted Mufcles.
74. For if a double Fibre $a \varepsilon$, were two Incies long, which, by contraction or fwelling, muft be blown up into the circular Figure $a b c d$, the faid Circle would be 4 Inches, and its Diameterb $c$, above one Inch and a Quarter ; as is plain to thofe who know that the Circumference of a Circle Is to the Diameter, As 22 to 7 , or thereabouts
75. We have chofen here to reprefent an extended Fibre rather by a long Line, and a contracted one by a Circle, than by a Tube and a Glcbe, to which there Refemblance bears greater Affinity; becaufe we wou'd render the Matter as intelligible as may be to ail Capacities.
76. Secondly, If the whole Fibreconfifted of one Machine only, as abcd, and one fhou'd cut it aciofs at $b c$, the whole Fibre would at once be difabled from concracting, or exerting its drawing Power, fo that it could never draw itfelf back to $a$; bat more efpecialy, if the Contraction be performedby filling the Machine, or by the Expanfion of any Matter included rhercin ; but in a Mufele cut acrols, Experience proves a Motion or Conträction, even after its Fibies are cut afunder.
77. If now the Fibre confifted of two Machines, akgmandghdi, and which fhou'd be divided from one another at $b c$ through $g$, the firft Machine mulf be contracted to $a$, and the fecond to $d$.
78. But if this fhould happen at $k m$, the Part $a \mathrm{~km}$ being cut through, would not be able to contraet it felf to $a$; not to mention the too great Thicknefs of $k m$ (as was obferv'd before concerning $b c$ ) for which would be equally contradictory to Experience as the former.
79. Hence we are taught, that (Tal. VII. Fig. 2.) when the Fibre is cut through at $b$ or $g$, or $k$ or $l$, or whatever it be, each Part is drawn back to its Tendon to which it is faftened, that is, to $a$ and $p$; for Inflance, if the Fibre be cut at $g$, the Ma chines between $a$ and $f$ and drawn to $a$; and thofe between $g$ and $l$ to $p$; and thus we fee, that by this means the Cut made through any Mufcle is vifibly larger than then the Knife which made it.
80. From whence we may conclude, that on both fides of the Cut, whether at $g 6$ or elfe where, there mult remain fome Machines unwounded, which have in them a contracting Power, notwithftanding the Separation; and by this means the Fibre is drawn inward, or contracted, after it is cut through in any Part.
81. For if either fide fhould be left deftitute of thefe Machines, fo that none were to be entire or uncut, the Confequence muft be, that that fide fo deprived of thefe Machines, could not be in a Condition to contain the Matter which is the Caufe of the Fibre's fwell ling; and confequently the Fibre could not be actuated by any Power which would draw it towardsits Tendon.
82. But feeing it is fcarce poffible to cut a Fibre through fo near $a$ or $p$ (viz. at $m$ or $n$ ) but that the Parts, as we find Experience, do flfrink on both fiules, as well the fhort fide as the long, to their refpective Places.
83. Itfollows then, that how little a Part foever, uch as $a$ or I, be cut off from the Fibre on one fide, ceing it fhrinks back, it muft neceffarily contain ome Machines, at leaft one entire one; in it felf.
84. And confequently from hence we may plainy conclude, that the Machines, whereof the Fiores are compofed, muft always be, each of them n particular, fmaller than the Part cut off; and herefore of a wonderful Smallnefs.
85. From whence, then it follows, that the Numper, at the fame time, of thefe Machines, if the Fibre e of any confiderable Length, muft be very great.
86. Borelli (from whom the Reader may receive ufficient Satisfaction, colicerning the multitude and nimutenefs of the fe admirable Mechanifms, $\varnothing$. I 15.) naintains, that fince every Fibre is fmaller than a Woman's Hair ; each Cavity ABCDE (Tab. VII. Fig. 1) which being contracted, forms a Machine $a b c d e_{i}$ nuft therefore be fi ner than the faid Hair.
87. Now if thefe Machines be as broad as 'ong, sach Fibre will contain as many of them lengthwife, as there canlie Hairs breadth-wife on the faid Lengeth of this Fibre.
88. But according to the Calculation of the faid; Borelli ( $($.ibid.) fifty Fibres, placed breadth-wife by one another, do not amouns to the fpace of one Inch:
89. Wherefore, according to this Computation fifty of thefe Machines muft go to conftitute a Portion of a Fibre of one Inch in Length.
90. But for Caution fake, and to keep withini Compafs, that Author does not calculate above twenty Machines for every lnch of Fibre.
91. Which Calculation we may fafely allow him; becaufe, if any one may think it more convenient to imagine thefe Machines not to be altogether as broad as long, here is room enough to humour any fuch Conjecture : For by this means, thefe Macinines will have their Length exceeding their Breadth by

[^4]$\mathrm{N} \quad \frac{1}{z_{3}}$ i.e.
$\frac{1}{2}$, i, e. they will be more that three times as long as broad.

92 To return then to the Force of the Mufcles; there appears here, in each Fibre, a new Inftument of the following Structure ; viz.
Firf, We fee, in Tib. VII. Fig. 1. a great Machine W G, confifting of feveral fmaller ones, as $A B C D$ E, ひ̛c.

Secomilly, That they are fo formed, each little Machine, A or B , being contracted by a particular Force, into Circles or Squares, or other Figuires, i. e. expanded, as at A or $\mathrm{B}, \dot{\sigma}$ c. or ocherwife (in another Form) at $a$ or $b, \dot{G} c$. contributes its fhare towards raifing the Weigit $T$.

Thirdly, That being joyned, or I nked, to one another at $a, b, c, \mathcal{O}_{c}$, they do likcwife affift each other in raifing the faid Weight.

Fourthly, When this Machine, wus, confifts of more or fewer little Machines, as $a, b$, c, cic. which operate here at the fame time, the Weight T muft accordingly be raifed to a greater or lelfer Heighth (as the Number of Machines are multiplied or diminited) and confequently the fame Weight T , will be mored with greater or lefs Velocity: For Infance ; if there be ten times as many little Machines, contracting themfelves, the Weight T will be raifed ten times higher; and at the fame time, it will acquire ten times more Velocity.
93. All thefe Properties being fo ufeful and neceflary for a right Conception of the Motions of the Mufcles; and being a neceffary Confiquence refulting from their Structure; we thall endeavour to demonftrate them by a Machine (adapted by Mechanifts to other fort of Uies) which feems to have a pretty near Refemblance to the Nature and Office of the Muifcles in general, and to give the beit Light into this Matter.
94. Let us then fuppofe a Machine (Tab. VII.

Fig. 4 in which a Weght $T$, hangs at a Cord, Which being wound about the Pullies $\Gamma a, 2 a$, , $c$. and $I b, 2 b, \dot{G}$. in the manner defcribed by the faid Figure, is terminated and faffned to the Nail d.
Then to eaci Puiley, $1 b, 2 b, 3 b, 4 b$, let there be fuppended an equal Weight $g h m n$; which four equal Weighits, preffing altogether, downwards, the Weight $T$ will be thereby raifed up and kept in Equilibrio.
95. Now we may fee in this Machine of Pullies, all the fame Phanomena which have been marifefted in the mufcular Fibres (92); namely, that the whole Structure confifting of many little Machines, each does, by a-proper Force, bear a refpective Part in raifing the Weight $t$; which altogether united, accumulate their Powers fo as to prove mutually affifting the one to the other.
96. For, if the Cord be carried only from $t_{3}$ through $1 a, 1 b$, and terminating at $e$, be there faff'ned to a Nail; we have a Machine, which zating by the fole Power of g, raifes t. And in cafe the Cord be continued from the Naile, on to the Pullies, $2 a$ and $2 b$, and be faff'ned to another Nail at $f$; this will be a a fecond Machine aeting by the Powerh; which, if it be joyned to the firt, will help to raire the Weight $t$.
97. If there Machines and Weights be multiplied; by continuirg the faid -Cord farther on thro' 3 a and $3 b$ to $i$, and from thence thro' $4 a$ and $4 b$ to $d$, and fo on ; and a diftinite Weight furpended to cach, as $m$ and $n$.
We fhall have a grear Machine produced, from all thefe iitele ones, in which the three firf Things expreflied in Prop. 92. and repeated in Frop. 96. will occur.
98. We fee likewife, that the fourth Thing decribed (Prob. 92.) which feems to be of the greatfit Importaace in this mulfuiar Demonftration,
does here meet with an exatt Refemblance ; viz. by how much the Number of little Machines is multiplied, by fo much the more fwiftly will the Weight $t$ be raifed up.
99. This is ealy to be apprehended by Confideration, without the Circumftances of Demonftration; ifg only acts on the firf Machine, which is fuppofed to end at e (96) and the Centre of the Pully, $I b$, being firft to $r$, is drawn down to $I b$, fo that is has twice $1 r$ added to its Length, in a terminate fpace of Time; fuppofe in one Pulfe or Second of a Minute, the Weight $t$ will be raifed to $T$, in the fame fpace of. Time the heighth of $T$, which is equal to twice $I d r$.

Becaufe the Pulley $\boldsymbol{r} b$ being thus run down from $r$ to I $b$, the whole Cord, I $a$, I $b, e$, paffes thro' the Pulley I $a$; which Cord retains, as we fee, on each of the two Sides, viz. on the Side i $a \operatorname{l} b$, and on the Side I $l e$, the Length of I $b r$; and confequently is twice the Length of $x b r$.

Now in proportion to the Quantity of Cord, running thro' the Pulley I a, the Weight $t$ mult be raifed from $t$ to $T$; which muftneceffarily be twise the Length of $I b r$.
100. If now we joyn the fecond Machine, the Cord of which ends at the Nall $f$, with its particular Weight $h$, it may be eafily (96) inferred that when both the Powers gand $b$ concur in their Op ration, to draw down the two Pullies I $b$ and $2 b$. from $r$ and $r$, which are above (the Length of I $l$ $r$ or $2 b r$, which are equal) in fuch cafe, I fay, it may be inferr'd, that four times the Length of I $\mathrm{bi}_{i}$ paffes thro' the Pulley $\mathrm{I} a$, exactly in the fame fpace of Time ; as may be feen by the four Cords, ABC D ; and confequently, that the Weight $t$ will be raifed to $T$, the heighth of $16 r$, multiplied by four, in the fidd fpace of Time.
ror. If therefore thefe Machines and Powers,



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$m, n$, were to be further multiplied, and all the Weights drawn down together, in one Second of Time, it is plain that the Weight $t$, according to the Number of Machines, muift always, in the fame Space of Time. be raited higher; and confequently move with greater Velocicy.

And thus what is faid (92) concerning the Force of the mufcular Fibres, is demonftrated in this Machine.
102. Now, fince this Machinc of Pullies operates after this Manner; thofe who are verfed in Mechanics know that it is endow'd with the following Properties.

Firft, That altho' we take a greater Number of the feverallittle Machines, and the Weight $g, h, m$, $n$, that draw them, yet they, joyned all of them together, will not be able to raife or poife in Equilibrio a greater Weight than $t$ or T ; which g only, operating by itfelf, cou'd poife the fame way.

Secondly, But the Velocity, wherewith the Weight $t$ rifes to T, will, by the Multiplication of thefe Pullies, be proportionably augmented; viz. by how much the Number of thefe Pullies are encreafed, by fo much fwifter will the Weight $t$ rife up to J .
103. To prove this, let us fuppofe the Pullies, $4 b, 3 b, 2 b, 1 b$, (Tab. VII. Fig. 5.) to be each of them brought inwards to $r, r, r, r$, by the gravitation of the Weights T T falling down to $t$; fo that the Pullies on each fide, to wit, $1 a, 2 a, 3 a$, $4 a$, may be in the common ftreight Line $d Q$, indifcriminately equal with the others, $1 b, 2 b, 3 b$, $4^{b}$; the ftreight Line, $r, r, r, r$, paffing direatly thro the Centre I $a$, form thence thio $1 b$, at the Center, and fo on; in this State the mufeulat Fibre $d \mathrm{Q}$ is to be apprehended to be extended to its tull Length, and confequently inactive; and each little Space; $d d$ R R, R R-S S, SSBB, and

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BBQQ , will perfecty reprefent the littic Machines of a Fibre which is in the State of Reft.

But if now the Side $d \mathrm{R}$ beextended both Ways, to $d \mathrm{D}$, the Space $d \mathrm{D} R \mathrm{R} \mathrm{D} d$ will in fome meafure, give us a Reprefentation of one of the Machines of a mufcular Fibre inflated, or fwellicd up, in performance of its Function; becaufe the Cord by which the Weight T T is fufpended, is raifed fo high by the faid expanfion or fwelling, and fhortned at the fame Time fo much below : By this Means we receive a grofs Conception of the Action of the Fibres.
104. Since therefore the Properties enumerated (102) are very fitly'applicated to this Machine of Pullies, as well as to every Fibre, which it is purpofely adapted to reprefent; it occurs that the fixth Obfervation fhou'd here meet with an Application.
105. Namely, that in order to compute the Force of a carnous Fibre, we muft, according to what has been lately proved, multiply the Force of a fingle Machine of the fame Fibre.
106. Now Borelli computes, (\$. 124.) that each of the' carnous Fibres of the Deltoides, viz. G IV (Tab. VI. Fig. ..) is two Inches in Length.
107. And, according to Prop. 90. each Irchi contains the Number of 20 little Machires ; fire only (for Example fake) are marked here on tiee Fibre G W.; confequently the whole mufcular Fibre G W, being two Inches long, contains 40 of thefe little Circles, or rathier litetle Globes.
108. Each of thefe little globular Machines, G M (59) can exert a Force of 223 Pounds, towards raifing $T$, or a Weight of $5 s$ Pounds, whichy hangs at the Elbow; becaufe (by Prop. 102, and 104.) one fole Machine, GM, can act as much as 40 in making an Equilibrium.
109. So that by multiplying the Force of 223



Pounds (which one fole Machine G M exerts) by 40 , or the Number of fmall Machines in a fingle Fibre of the Deltoides, we difcover the Force of the whole Mufcular Fibre G W; i.e. 40 Times 223 , or 8920 Pounds.
110. Now fince this Deltoides is fuppos'd to confift of two plumiformar Mufcles, each containing two diftinct Sides, or Ranges, of Fibres, as GVP and GPW, in the Mufcle GVPW, as alro HQZ and HQL in the other plumiformer Mufle HZ QL, in all four Sides (each Side here being reprefented by a* fingle Fibre G W) we muft multiply (109) this Sum 8920 by 4, in order to find the Force of the whole Deltoides, which will then prodace a Force equal to 35680 Pounds.
rir. Now tho' this proves fuch a Force in this Mufcie, as perhaps might feem incredible to a Perfon not conceiving the Demonfration; and tho' this Force itfelf be more than fufficient for our Parpofe, yet we fhall however fubjoin the Demonftration by which Borelli makes appear a Neceffity of even doubling this Force.

II 2. Viz. It is obvious to Perfons skill'd in Mechanicks, that a Cord K T (the Weight K (Tab. VI. Fig. 6.) being fufpended to one End of the Cord, the other End being at the fame Time faAtin'd to a Nail T, which renders it there imnovable) fultains as great a Weight, or Force, by the Sulpenfion of the Weight K alone, as if it bore doube the Weight of K.
113. This is manifeft; becaufe the Nail T contributes as mach to the itraining of the Cord K T, as if the faid Cord K T, had another Weight, $m_{1}$ equal to $K$ in Gravity, hanging at the other End, which is fuppofed to be carry'd round the Pulley $r$; for this laft Weight K may be perceiv'd

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to be as well balanced, or kept in Equilibrio by the Nail T, as by the other Weight $m$, equal to itfelf.
114. They who defire to fee this Matter demont. ftrated more at large, may confult the aforenamec Borell's ingenious Treatife, De motu Animalium, if the 1oth Chap. of the firft Part; it will anfives our prefent Purpofe, if thefe Matters be mady meerly intelligible, for the Ufe of fic c̣a as are no thoroughly verfed in Mathematicks.
115. Now to apply this to the Murcles (Tab) VI. Fig. 1.) it is plain from what has been (faid that the Mufcies there defcribed, do reprefent Sort of a Machine of Pullies; ore End of the Fi bres GV,GW, ZH, HL being faflen'd to the Tendons, V P W and ZQL, which adhere a immoveably to the Bones, às the Cord sin the Ma chine of Pullies do to the Nails $d d$; whilft thi pther, and moveable Ends of thefe Fibers G V G W, Z H, H L, do each of them exert a Forad (62) 'equal to 223 Pounds; or the Power of eact of thefe moveable Ends is equal to the Weight q which is fuppofed to wcigh 223 Pounds: But al thefe four Fibres operating together, will balano a Weight of 892 Pounds.
116. If, according to $P$ rop. I12. this Force $b$ doubled, the Force which this De.toder exerrs by the Pofition of each of its Fibres, amounts th 446 Pounds; and the Forces of all four acting to gether, to 1784 Pound's, befides the Multiplica tion of this Number by 40 , which we arc goins to fpeak of, and concerming which, Mention ha been made already, Prop. 63.
ti7. And fince we have hitherto fuppofed, tha each Fibre, in thefe Demonftrations, is endower with pine or more Machines, like G M; and for afmuch as, according to Prop. 102, and 104 , on fuch Machine, as $G \mathrm{M}$, can balance as s, Weight as all the 40 Machines of the whole Fibr


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G W ; it will appear, fince the Force exerted by each Machine is equal, that in order to calculate, or make an Eftimation of the entire Force of the whole Deltoides (or of the four mufcular Fibres conftituting it) we muft multiply this Number $17^{8} 4$ by 40, or the Number of Machines in each Fibre, which amounting to the Sum of 71360 Pounds, is the Force which (according to Prop. 102, and 104.) the Deltoides is capable of exerting.
118. Here this (Tab. VI. Fig. I.) may likewile ferve, in fome Meafure, to demonftrate from the foregoing Principles, the Force of the Mufcles called Glutai, when they exert their Power in raifir:g Weights fufpended to the Heels.
119. The Glutans Major, which is the Mulcle we are to fpeak of, is, according to Borelli, (\$.83.) made up like the Deltoides of plumiformar Parts.
120. Suppofe then B to be the Heel; $d$ the Knee; K EF A the round Bone in the upper Part of the Thigh; the Weight, to be raifed by the Heel B, mlift, according to Borelli (l. 85.) be computed to weigh 6s Pounds.

12 1 . We perceive here, that the Shin and Thigh-• Bone together (which are reprefented by BC) comprehend, in Length 3 I Semidiameters of K C, or the round Bone of the Thigh.
122. If therefore an Equilibrium be to be made betwixt the Tendon DK 1 and the Weight T ; the faid Tendon cannot be raifed to X , by a Force lefs than 31 times 65 , or 2015 Pounds.
123. And if this Force is to be extended by two other Tendons DH and D G; each of them will not only bear the half of 2015 Pounds; but becaufe they draw in an oblique Direction, will fo much exceed the Hail, or $1007^{\frac{1}{2}}$, as D G exceeds D X in Length.
124. But Rorelli fays, in relation to that ( $\$ .83$.) that the Angles of Obliquity X D G and X D H are each of 45 Degrees.
125. Confequently (by the Tables of Sines, and cafting away the five laft Eyphers) as the Radius, 100 : To the Secant 45 Degrees, 141 :: So $1007^{\frac{1}{2}}$ : To 1420 Pounds.

- 126. So that each of the Técions, D G and D H, being drawn obliquely, muit be acted on as if a Woight of 1420 Pounds, like DP or DQ, were fufpended over the Pulley $P$; otherwife their Force will not be equal to the Weight or Power which draws K D, aceording to the Direction K X.

127. And again ; at D G, there are two other oblique Fibres, GW and G V : Thefe, to operate in like manner with the former, will each of them contribute a Force fufficient to raife the haif of 1420, viz. 7 ro Pounds, gravitating perpendicularly in the Dircetion G P.
128. But becaule they draw obliquely the Force which draws accordung to $G W$, will fo many times excced 710 Pounds, as GW exceeds G S in Length.
129. According to (\$.83.) of Borehi, the Obliquity of this Angle is 8 Degrees.
130. Therefore by Prop. 58 .

As the Radius 100000 : To the Secant of 8 Degrees, 100952:: So 710: To 716т\% Pounds.
131. Therefore each Fibre G W, reprefenting here one entire Side, GPW, of this piumiformar Mufcle, muft in the Cafe before us raife a Weight of $716 \frac{9}{2}$ Pounds.
132. But further, according to Borellh's Computation ( 9.125 .) each of thef Fibres is of the Length of three Inches; confequently each contains in its Compolitions 60 Machines.
133. Therefore let $716 \frac{9}{\mathrm{~T}}$ ( (the Force found according to Prop. 130 .) be multiplied by 60 .
134. The Product of $716 \div \frac{\%}{0}$ multiplicd by 60 , 43014 Pounds, equal to the Force which this one ancufcular mulcular Fibre G W (or even the whole Side of one plumiformar Mufcle, to which this Fibre is fuppofed to be equal) exerts towards raifing up a Weight.
135. Now it being taken for granted, that the Mufele DQP, confifts of two of thefe plumiformar Muifcles GWP V, and H LQ Z, containing betwixt them, four Sides: Therefore thefe two Mufcies exerting a joynt Force, will (by Means of their four Sides, or four fuch Fibres as (GW) exert a Force equal to four times 43014 , or 172056 Pounds.
136. But feeing that this Mufc'e does adhere at one End to a Bone, as if it were a Nail T, (Tab. VI. Fig. 6.) by its immoveable Tendon; and is only moveable, fo as to carry a Weight, like K, at its other End; this Force is therefore yet to be doubled; becaufe the Mufele, by ies being faft'ned at one End, fuffers as great a Strain, as if had an equal Weight fufpended over a Puliey, at the other End.
137. Wherefore doubling 172056 (the great Force of this Mufcle) we find that 344112 Pounds does correfpond to the Power that the Mufculus Glutans Major can exert in performing its FunEtion.
138. And this is what we take to be fufficient to infinuate a general Idea of thefe Matters : If any one defires to fee a more accurate ard exaft Account, he may meet with more ample Satisfaction in the faid Book of Monfietir Borelli. We have been more brief in this Infance of the Glutans, becaufe we judged it a ncedlefs Trouble to repeat Verbatim what has been demonfrated more ful $y$ before in the Cafe of the Deltoides.
139. We might here conclude this Work, of demonftrating the Force of the Mufcles, if fome Objections did not intervene, which might hinder Perfons

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Perfons not thoroughly skill'd in Mechanies (for whofe Sake we condefcend to this prolix Way of Demonftration) from acquiefcing in the Prooff that have been deduced from mechanical and mavi thematical Obfervations: Thefe Objection therefore we fiall endeavour to obviate by fiutable Remarks or Obfervations.
140. The firf Difficulty that may perhaps be farted, is that in Tab. Vl. Fig. I, we have reprefented one fingie mulcular Fibre in the Room of an innumerable Number of others, which coniftute the whole Side of the plumiformar Mufcle GWP: Moreover, it feems agrecable to Obfervation, that one of thefe plumiformar Mufcles, reprefented by GVPW, is not confined to two plain Side, GWP and GVPt but diffufes its carnous Fibres, Pyramid-wife, in great Multitudes from a Point, as G, like a Verticillum or Wheel, in the Shape of the Extremity of the inverted Pyramid, VGW: This happening from all the Points, G N, ©́c. of the middie Tendon G D, there Fibres do in no fathion reprefent a Plane; but confitute the Figure of a perfect Body, with Length, Breadth and Thicknefs.
141. In anfiver to this; to fhew that our fuppofing thefe Mufcles to confint of plane Sides (which is a Method we have judg'd molt expedient to convey thefe Demonftrationis to the Underftanding) does not in the leaft alcer or enervate the Force of the Demonftrations; and to prove that the fame prodigious Force wou'd manifét it felf from every particular mufcular Fibre, tho' the Calculation had been made from a greater Number of the Fibres of a vercicillated Body, inAcad of the two Fibres G W and G V.
Let fuch as read this, confider, Firft, that as we have ouly taken two Fibrec, G W and G V , for the two Sides of the Mufcle, viz. GPW and $G P V$

GPV (whether folid or plane) fo likewife we have only afcrib'd half of the Force of the whole Mufcle, G VP W, to each of thefe two Fibres, as by ( 61 ) where the Force of one carnous Fibre, acting according to Propofition 59, was found to be equal to a Weight of 223 Pounds; to reprefent the Force of the whole Mufcle G V P W, we were under an Obligation of doubling 223 Pounds; fo that the full Force of a Mufcle is reprefented by the Force of two Fibres, or 446 Pounds; this is the Foundation of what is to follow.
142. Now, for the Benefit of unexperienced Perfons, we thus compute, that the Force of a Mufcle is the fame, whether this Force be imagined to be center'd in two Fibres, as GW or GP; or whether the Force be diftributed amongtt in infinite Nnmber of Fibres, contained in the space GVWP; which Space you may imagine, if you pleafe, to be occupied by a Body confifting of Length, Breadth and Thicknefs, and not a mere plane Figure.

To this End, fuppore (Tab. VII. Fig. 6.) a Weight D (not unlike Tilb. VI. Fig. 4. and Prop. 48.) of $44^{2}$ Pounds, fufpended at a Cord D O S, and fupported by another equal Weight $q$. Now if we take away this Weight $q$, and balance the Weight D by a Number of other Weights faftned to oblique Cords, G, A, P, dic. each of which bears a Weght $m, h, g, p, n$, ©fc. on this Account.

If we now conceite the Cords to be fo order'd, that there may be imagined 100 Points, like GAP, \&゙c. in the Length of the Cord GO, to which the oblique Cords, GW, GQ, AB, AE, dic. are faftned: And moreover, that there are about each Point, as G , or A , or P , Úc. not only two Cords, as here at $G$ and $A$, bat imagine 10 to be placed round the Circle, like the Spokes of 2. Whect, or Veiticillus of a Plant; four fuch Cords
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we have defrribed to iffle from the Point P, viz. P V, P T, P H, PR.

Laftly, let it bealfo fuppofed, that the Weights $g, h, m, n, p$, are equal to one another; and that the oblique Angles, MGN, BAP, R P O, © $\sigma$. which each oblique Cord makes with G O, are alfo equal, and of 8 Degrees each.

It is therefore demanded, what the Weights $g$, $h, m$, \&cc. drawing obliquely, amount to ? And how great a Force they mult altogether, in Conjunction, exert, in order to balance the aforementioned Weight D.
143. To find this, it muft be confidered, that we have imagined the Weight D to be drawn by a thoufand Weights, equal in gravity to one another: Since (according to Prop. I42.) there are fuppofed to be roobliquely drawing Weights, and alfo we have imagined 100 fuch Points as $P$
144. Wherefore each little Weight $g, h, m, \mathcal{O}_{c}$ muft raife one thoufandth Part of the Weight D; or according to (142) a Gravity of $-\frac{44}{5} \frac{2}{0} 0$ Pounds, which each was able to fuftain in the dircet or perpendicular Line G O.
145. But confidering that they draw obliquely, each fuch Weight as $m$, muft exert a Power fo many Times greater than $\frac{4}{5} \frac{4}{0} \frac{2}{0}$ of D , or than $\frac{4}{5} \frac{4}{0} \frac{2}{0}$, as the Line M G is longer than N G.
146. Now forafmuch as the oblique Angle N G M, of each is, according to Borelli ( 57 ) of 8 Degrees; therefore by ( 58 ) if G N be 100000 , GM mutt be 100982 : It follows (if they operate proportionably) as G N: To G M: : So $\frac{-4 \frac{2}{5} \frac{2}{0}: ~ T o ~}{\text { : }}$ $\frac{44+5}{10} 5$.
147. So that each little Weight, as $m$, muft have the Gravity of $-\frac{4}{1} \frac{46}{6} \frac{6}{6}$, which is the firf Po ftulatum (I42.)
148. Now the Method, by which the Power of all there little Weights, when they exert themfelves
n order to raife D, or 442 Pounds, is to be difcoer'd, feems to be the plaineft thing in the World : or do but multiply, the Force which one of them, $s m$ for inftance, exerts, viz. $\frac{44 \frac{4}{0} \frac{6}{5} \text {, by the Number }}{}$ f all the little Weights, that is by 1000 , and the Product is the Force of them ail acting together, which appears to be 446 Pounds; the fame which vas demonftrated by the joynt Action of only two Fibres.
149. By thefe Weights and Pullies, you may magine all the Power which is exerted by every ingie Fibre of a plumiformer Mufcle, fuch as $G$ $V$ P W (Tab. VI. Fig. 1.) to meet with a juft and malogous Reprefentation.
150. For you may obferve, that Weight of 446 ounds is as exactly equivalent to the Power exrted by this whole Mufcle G V P W, when you ave fuppofed it made up of a thoufand Fibres, as when before, according to (61) we imagined ir to onfift of only the two Fibres, G W and G.V.
151. And from hence, by a little Attention, what we have faid above, at Prop. 141: may apear exceeding plain and eafie to any ordinary $\mathrm{Ca}-$ racity: Namely, that altho' the conftituent Fires of a Mufcle were imagined to amount to ten, or a hundred, thoufand, of the highef Number ou can fuppofe, the very fame Force, of 446 Pounds, will always, by thefe Methods of Calculaton, be the refult of the whole.
152. And to proceed yet further; we fhall find he Deltoides exerting the very fame Force; tho' we fuppofe (Tab. VI. Fig. i.) to be an unjuft Rerefentation, on the account of the Number of the dumiformer Muifeles; tho' we imagine the Delwdes not to be confined to two, as reprefented by GVPW and HZ QL ; but contrary-wife, to be adowed with many of thefe plumiformar Parts; et we flall cafily peresive, that the Force, or

Power of it being calcullated according to the foregoing Rules, the Whete will be exaetly congruous to thic Power or Force already demonffrated.
153. And thus the Objection, which feemed to oppofe this Hypothefis with the greateft Appearance of Reafon, vaniffies; and the Difficulties, under which might labour to conceive the poffibility of two fuch Fibres, as G.W and G V, being, able to fupport together $4 . t^{6}$ Pounds, or each of them fingle half of that Number, are quite cleart ed and taken away : Efpecially when it is confider'd that we have only all alone laid thefe things down by way of Suppofition, but by thefe Data however, the whole Force of the Murclecomes to be exactly accounted for: The Confequence proving the fame, whether we fuppofe the Murcle confiituted of a million of Fibres (as in all appcarance there are a valt Number) or of only two.

Let the Figure or Striciture of thefe Mufcles be what it will, this Method may ferve for a Sample to fhew by what Methods their Power and Force are to be inveftigated.
154. In all the fe Reflections, viz on the prodigious Number of Fibres; on the curious and peculiar Form of the Mufcles, which reprefent Feathers joyned to a Tendon, as to a Quill (on which Topick confult Tab V. Fig. 10. where the Structure of the Deltoides is drawn from Steno's Myologia;) and, laftly, on the prodigious and almoft incredible Force exerted by them ; in reflecting, I fay, on all thefe thefe, the adorable Wifdom of the great Creator, muft moft fingularly manifeft itfelf.

Steno reprefents the Deltoides confifting of 12 fingle Mufcles; that is fix plumiformar Mufcles on each fide: And if you imagine the empty white Spaces, above and below, to be full of carnous Fibres (as Steno affirms, p. 53 .) how vaft muft the Number be conceiv'd to be? And as to the Force;
which Steno demonftrates them to exert, according to his form; it cannot be much lefs than he afterts. But we have chofen rather to follow Borelli in our Reprefentation, according to Tab. VI. Fig. I ; becaufe by this Means we apprehend our Demonitrations better adapted to Gapacities unexperieliced is Mechanics.
155. But to penetrate further into the prodigious Number of the Fibres, and to difcover, as far as poffible, the wonderful Defign of the Creator, we need only obferve ( to keep to the inftance of Tal. VI. Fig. I.) that the two Fibres, GW and G V, are found to Balance feparately, a Weight of 223 Pounds (59) that is jointly 446 Pounds; as they reprefent together, the whole plumiformar Mufcle G VP W.

If now, inftead of two Fibres, we fuppofe ( 143 , Jc ) this Mufcle to comprehend 1000 Fibres; each ot thefe thoufand Fibres will bear $\frac{4+ \pm \frac{6}{0} 0}{0}$ of a Pound ; that is not half a Pound to each Fibre.

And if the Number of Fibres were to be imagined greater, the Weight aferibed to each, to bear for its Portion, weu'd prove much lefs: Or if the Deltoides, according to Tab. V. Fig: 10. inftead of two Mufcles comprehend fix (154); each Muicle could then have its fare or burthen; but $\frac{3}{1}$ of 446 Pounds, which is not quite 150 Pounds each: Thus the 1000 carnous Fibres conftituting each Mufcle, cou'd have toits Share no more than ${ }_{T} \frac{T 5}{\circ} \frac{0}{\circ}$ or $2_{2}^{3}$ of a Pound.
156. Now who, apprehending this Structure of the Mufc'e, cain think on it, wifhout acknowledging the Wifdom of the Creator? Wino has made the Tendons tough and itrong enough to bear, without breaking, sthe Violence of the Force which they are obliged to fuffer in exercifing the Qualities they are endowed with: At the fame time, having regard to the Safety of the moft fine and tender Fibres,

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by laying no more ftrefs upon each of the Fibres it its Office than it is, by the Affiftance of fuch Multitude of its Fellows, able to fuftain, withou the leaft Injury.
157. For the Weight, which each Fibre fuftain will be much lefs than $2^{\frac{3}{0}}$ of a Pound (155) if th Number of Fibres in each plumiformar Mufck much exceeds it (as 'tis probable they do) 1000 which was what we fuppofed ( 155 ) them to be

It would therefore be worth any ones Treuble ti inveftigate the Number of Fibres in each Mufcle as near as poffible; not only to clear the determi nate Number of Fibres compofing each Mufch (which might be done by thofe who with accurac) pry into diffected humane Bodies) but alfo to ad juft exactly how many of thefe Fibres, placec breadth-wife, may be contained within the Spact of an Inch. Borelli fays ( $\$ .115$.) that 50 Fibre thus placed, will fearce amount to an Inch : And as to the Number of Fibres in each Mufcle we may judge, from the Flefh of Beafts, that many of thefe carnous Fibres make but a fmall Portion of fuch mufcular Flefh as we daily ufe in Food.
158. We fhall ceafe to admire at what is advanced in Tab. VI. Fig. I. concerning the Pofition that is here laid down, viz. that one fole little Machine, G M, of the Fibre GW (and fo of the other Fibre G V) is able to fupport 446 Pounds, when we confider what follows:

The foregoing Propofitions have made appear that the ftrels laid on each Machine, as G M, bearing not more than its Fibre G W, will not amount to $2^{\frac{3}{0}}$ or two Ounces and a half.
159. Thus the fwiftnefs of the Motion imparted to the Weight T , by the contraction. of the little Machines A B C, ©r. (Tab. VII.Fig. r.) where each of them are drawn up into the Form of $a, b, c$, Uc. will not appear fo improbable; feeing that if
there were no Weight, fuch as T, fufpended, the Conclufion (viz. that the Fibre to which $\mathbf{T}$ is fufpended, muft raife with the Velocity above-mentioned) wou'd be in itfelf the moft obvious Thing in the. World: Becaufe, by the foregoing Propolition, the Weight is reprefented fo fmall, that a fingle Fibre or Hair, can be put to no great ftrefs to bear it ; efpecially, confidering that it has been already declared, that the Weight of 223 Pounds aferibed (59) to a fingle Fibre (which is the chief Thing that can raife any Difficulty) is only thus Cuppofed by way of Hypothefis ; for the conveniency of conveying to the Mind fuch a jutt Idea of the Matter, as may do no wrong to the real Calculation
160. Now fince we have thewed before ( IOg ) that tho' the mufcular Force be ever fo much augmented by the multiplication of thefe little Ma thines; yet, their difpofition is proved to be fuch, that they all acting together, cou'd not raife the Weight fufpended to the Elbow if it had been but one Pound heavier; and that the multiplying thefe Machines does only ferve to encreafe, or multiply, the Velocity of the Motion.

Therefore, Perfons not thoroughly acquainted with Mechanics may yet, feem to queftion, how it :an be poffible that the Force of the Mufcles is eally augmented, when the Weight which is raifed sin no wife encreafed.

To anfwer this, they ought to be informed, that i really augmented Force is as much required to encreafe the Velocity of Motion, as to raife a greater Weight with the fame Velocity: This is wiat all Mathematicians know.

This alfo is made appear by the Pulley Structure 'Tab. VII Fr. 4,) where the augmentation of the Velocity with which the Weight T is raifed, refuires cach time more Force and new Weights, as $n, n$, Urc. See the 5 th Remarl, 102.
161. That this obtains in other mechanical Insftruments, is what Mechanifts are convinced of, and what may be eafily obferved: For fuppore (Tab. VI. Frg. 7.) AB to be a Balance or a Steelyard, turning about D , and the Arms A D and $A B$ to be equal; as alfo, the Weights $A$ and $B$ : ${ }^{2}$ Tis very plain, that the faid Steelyard A B being turned into the Pofition MK, the Weight A will run down the Arc A M, and the Weight $B$ down the Are B K in the fame fpace of Time; and that the Arcs being equal Parts of the faid Circle, they muft likewife move with equal Velocity.

Therefore if the Weight B were to be balanced, when its Gravity is encreafed thrice as mich as it was, or when two equal Weights G and H are added to it, the Weight A muft neceffarily be affifted by two others of equal Gravity, or have its Force multiplied by three, as we fee it has when the Weights E and F are added to it. Again, if we wot'd make B move with a Velocity three times as fwift as it had before, let the Point B be removed to C, fo that D C may be thrice as long as D B: Wherefore, when the Machine turns, and A deferibes the Are A M, the Weight C will deforibe the Arc C L, in the fame fpace of Time, which being thrice as great as A M, therefore the Weight C runs thrice as great as A M, therefore the Weight C runs thrice as fwiftly as A or B .

But to balance this Weight C, when it moves thrice as faft as B, it is plain that the Weight A mult be multiplied by three, or receive the Addition of two other Weights, each equal to iffelf, fuch as E and F ; otherwife it cannot raife up the Weight $B$, which, placed at $C$, is equal to $B G H$; which happens on the account of that Velocity, receives a threefold Augmenràtion.

Thus the Objection ftarted in Prop: 160 is removed.
162. Before I conclude, 'tis incumbent on me to beg that the experienced Mathematicians will excufe my Prolixity; not only in the Demonftrations themfelves, but in confuming Time to anfwer fuch frivolous Objections as might be farted by Perfons unexperienced in thefe forts of Studies; which renders the whole too long and tedious for expert Judgments.

But if they'll pleafe to confider, that this Calculation is wholly devoted to the ufe of unexperienced Perfons, and not calculated for the Tafte of nice Mathematicians, who are too well informed in thefe Matters already, to want fuch mean Helps; 1 hope I may obtain their Pardon. The Perfons for whom thefe Demonftrations are collected, are fuch as being unexperienced, have not habituated themfelies to heap up together any confiderable Number of Lemmata, or previous Proofs, before they come to the Matter itfelf, whofe Judgments cannot be informed in Things of this Nature, withont enlarging the Stile, and defcribing Particulars more Verbofely; which is a Means, I have imagined, will convey my Defigns more plainly to their Apprehenfions.

They that defiee to view this Matter, as it is more experfly and accurately handled and demonflrated, may have recourfe to that well digefted Work, De motu Animalum, written by the great and celebrated Mathematician, Borelli: whole Principals and Obfervations we have here made ufe of; endeavouring in the mean time, to render his Demonftrations intelligible, by the concifeft and ealieft Mcthods we cou'd devife, to fuch as have but little Knowiedge of MathematicalStudies.

The End of the Demonftiation of the Force of the Mufcles.

Now to apply all this to the Views in which we have writ the fame.

1. How thefe Mufcles are adapted to the dif charging thofe Motions which they perform, with refpef to their Tendons and the Joynts of the Bones.
2. That to the End that the fine and flender Fibres may not be feparated nor torn afunder by the Violence of their Motions, the Mufcles are compoled of fuch an infinite Number of the fame, that each fingle one of 'em hardly draws, or bears any fenlible Part of a Weight.
3. That every Mufcle is form'd of fo many fmall Machines, the Ufe of which is only to perform their Offices with the greater Velocity and Nimblenels; as we may with Wonder obferve in the Motions of the Fingers, the Tongue, and many other Cafes.
4. That among fuch an incredible Number of Fibres, all of which are fo fmall as not toequal the Bulk of a fingle Hair of a Woman, no: one of" im can be dfplaced without Contufion and Harm.

Now can any Man, who is rightly inform'd of the Texture and Operations of thefe Mufdes, without being reproaeh'd by his own Cowfeience, pretend they are thus fram'd without Wifdom or Judgment? And the Man may juftly be laugh'd at, or rather be lamented, as one dertiv'd ot the ufe of his Reafon, that will reddily allow, thar none of the Tools of a Joyner or other Artificer acquire their Figure, and perform all their Ufes by mere Chance, oi from Caufes wholly ignorant of what they are doing; and yet to fupport his own Acheiftcial Notions, don't feruple to fay the Tame of this amazing Seructure of the Muicles. $O$ deplorable and obftinate Infidelity! which to avold own ing the Wildom of a God, that has wronghi fich Won-

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ders in the Bodies of all Men, is oblig'd to have Recourfe to fuch unjuft, unreafonable, and odious $\mathrm{O}^{-}$ pinions. For, that what happens to the Mufcles may be moft juftly deem'd wonderful, and indeec', almoft ineredible to thofe who don't iniderftand the foregoing Demonftrations, is deducible from hence; namely, that the Fibres of the only Mufcie call'd the Deltoides (as we have prov'd above in Numb. 110) are capable of exerting fach an amazing Force, and really do exert fuch a Foice in the Cafe there mentioned, as if all of 'em acting or gravitating together at the End of one Arm of an equally poifed Balance, were equiponderate to the Scale furpended at the other Arm in which there was a Weight of 35680 Pounds; from which alfo if there were but the Weight of one Ounce, or lefs, taken away, it would be able to raife up fuch an amazing Load.

Befides, we learn from what has been advanced above (Numb. II I, to II 7.) that thefe fame carnous and mufcular Fibres, as delicate and fine as they are, being joyn'd together, do acquire fuch a folid and ftrong Texture, that altho the faid heavy Weight of 35680 Pounds were fufpended at each End of 'em, both together, that is to fay, the whole Weight of 71360 Pounds could not (eparate 'em from each other.

Ler an Atheift reflect upon this by himfelf, as alfo of the Ufes which the Mufcles are found to have in human Bodies, and then let he himfelf Judge whether he can calmly and cooly deny that his adorable Maker is both powertul and wife.

After all this, can any one without being aftonifh'd at the Wonders of the Creator, confider that all the fliny Parts of his own, and of the Bodies of moft other Animals (which far exceed all the other Matter of the Body) are only compofed of moving Fibres? Each of which, as fine and tender
as they are, have their determinate Ufes; and in the manifo!d Extenfions, Directions and Difpofitions whereof, we may, as it were, feel with the Hand, thefe multifarious Views, Ends and Purpofes of a wife Creator?
SECT. XVII. The Different Coirrfe of the musculat Fibies.
In order to have a juft and true Notion of the varions and different Courles of the Fibres, we fhall reprefent to you a few Inftances in Tab. VIII. Fig. I. where in the Mufciecalied the Deltoides A, you may obfere the Fibres faft'ned immoveabic upon the Shoulder C, and to the Tube or Bone of the Arm turning to the Joynt of the Shouiderat D, letting the Arm hang downwards, as it is fiewn here with all its Fibres extended in their utmoft Length. But when thefe Threads between C and Date contracted with any Force, as you may fee them in the other Shoulder at B ; then the Arm mult be lifted up, as at B E.

The pectoral Mufcle K, being likewife here int feried in the Brealt-Bone, with one End of its Fibres at F immoveably, and with the other End D, in the Tube or Bone of the Arm, moveably; it appcars, that upon the Contraction of the faid F:bres they would draw the Arm, bending it at the Shoulder Joynt forwards to the Breaft.

If we view the Courfe of the Fibres in the Mufcte called the Latiffinus doifi A, A, ITab. VIll. FIg. 2.) on each fide, it appears that they draw the Arm downwards and backward's; for whicin reafon Anatomijts give it the Name of Ani-Scalptior.

In the Gafterocnemii BE, which lie in the Calf of the Leg, and are faftred the one above, about thic Kine at one End, as the other is below to the HectLone by a ftrong Tendon C; it may be obferved, that the Fib.es run ftrait downwards; wherefoic ipon the contradirg theyeof, thie Hee! Bore mift
be moved backward and upwards, and the Foot downwards. If one lifts up the Heei-Bone, and lay's ones Hand upon the Calf of the Leg, one may feel the Mufcles fwell and contract themfelves in that Place. Thefe few Infances may fuffice to give any one a general Notion of the Motions of the Mufcles by the Defcription of the Courfe of the Fibres whereof they are compofed.
Sect. XVIII. Convictions from the foregoing Obfervations.

This wonderful Structure of the Mufcles feems to me of too great Importance not to place them before the Eyes of fuch as are unexperienced in Anatomy, by the two Figures of the Mufcies, as they lye upon a Human Body, before and behind. (Tab. VIII. Fig. I, and 2.) taken from Dr. Brown; and very neceflary to give a Handle to all fceptical Philofophers to ask themfelves whether fuch a Machine as our Bodies (which is compos'd of as many other various and wonderful Machines as there are Mufcles in it, and all which are applicable to a particular neceffary Ufe) can ever be ima= gin'd to have been framed by Chance, and without Defign? And which is more, whether they are forced to own herein the moft perfect Wifdom, which has difpos'd of fo many thoufands of thoufands of Fibres, and allotted to every one of them its proper Place and Form according to the Purpofes for whieh they were made; and that all this is done in the Fluid or Liquor of an Egg (from whence moft, if not all Animals proceed) and there acquires its Figure and Nature? And further yet, does it notadifoover and make manifeft the Skill of the Malier, that this does not happen with fuch Order and Symmetry in one Thing only (which ir may, be an Atheift might affert, tho' without Reafon, to be puicly accidicul) but in Millions of other Objects ?

## CONTEMPLATION XI.

of the Bones.

## Sect. I. The Tranfition to the Bones.

NOW whatever Art and Wifdom appears in what has been faid concerning the Body; and with whatever Luftre the Things hereof may fhine, how neceflary and ufeful foever all its Veins, Nerves and other Parts may be ; yet all this amazing Structure would be in vain, and the whole Body, like a wet Sack, would cling or ftick together, and confequently hardly be in a Condition to exert any one Motion with Regularity, nor yet be able to remove one Foot out of the Place it was in; (wherefore it might perhaps have reprefented an ingenious and well-compofed Machine, but yet at the fame time would be really nothing more than a very ufelefs, weak, and pitiful Lump, )unlefs the gracious Creator had at the fame time vouchfafed to fupport it by the ftiffnefs and hardnefs of Bones, and fo render it proper to difcharge it, Functions.

Sect. II. The Scull and Bones of the Head.
THo' the Remarks that Anatomifts have made upon Bones are numberlefs, we fhall only here produce a few of the chiefeft of ' em . And,

1. Can it be thought there was no Wifdom exerted, when we confider that th: Brain being of fo foft a Matter, might have been eafily prefled and wounded by external Accidents to the Hazard of our Lives; to prevent the fame, it is cloathed and encompals'd, with a hard Subfance made of Bone, which we call the Skull? 2. That

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2. That this Skull does not confift of one only ard Piece, but of feveral Parts joyned together, vhich may be divided by a kind of intervening Suures, to the ead that they may be moveable, and relding in unborn Children, at the time of their Nothers Delivery; for want of which, Mother nd Child might both perifh.
3. That fuch Moveablenefs ceafes as the ChilIren grow in Years, when it would otherwife be rejudicial, and then the principal Ufe of thofe jutures, is to maintain a Communication beween the Membranes that encompafs the Brain ind the Skull.
We fee a great Proof thereof from hence ; foralfouch as at the Top of the Head where the fagitai and coronal Sutures crofs each other, there is ound an opening between the Bones, which in ew-born Chi'dren is all cover'd with a Memrane, upon which, if you lay your Finger, you aay perceive the beating of the Parts in the Head; ut in time the fame is filled and clofed by a foid Bone.
4. That the Skull, tho' every where of fo folid Subftance, has yet Holes in it in all Places where $t$ is neceffary, to afford a Paffage for the Medulla ipinalis and Blood Veffels from the Brain; partiularly, that there are found in the Ears fo many Angles and Cavities, artificially hewn out, as it vere in Bones as hard as Rocks, for the Recepion of the wonderful Inftruments of Hearing, plaed in fuch an Order as they appear to us.
5. That there is an Orifice in the upper CheckBone, thro' which the Air paffes by the Nofe into he Lungs; and for want of which, no Child could :afily fuck, nor full-growno Pcople themfelves, keep iny Liquor or moift Food long in their Moaths.

To fay no more, it is obvious enough to cvery me, low great the Inconvenience would be, if a

Man were forced to breath thro' the Mouth onlys, and not thro' the Nofe.

Now thofe who would take the farther Trow ble of confidering the Bones of the Head in the minuteft Circumftances thereof, and learn from Ane tomy the Ufes which the Diligence of Enquiren has hitherto difcovered; might fee, that among all the Number of them, that there is no Part, no Cavity, no Orifice, tho' never fo fmall, but what has its neceflary Ufe; and that not only for the Eafe and Well-being, but evell many times for the Support of our precions Lives.

## Sect. III. The Back Bone.

Bur now as the Brain is encompars'd with Bony Cale, that it may not eafily be affected by any external Inconvenience; the like Defence feemed to be not lefs neceflary to the Medulla Spinaby againft all outward Harms; for that confifting of the foft Matter of the Brain, muft be carried dow wards in order to communicate the Cpiritous Juic thereof, by the Nerves to many Parts.

To this Purpofe a hollow Tube of Bone, like that of the Leg, feems to have been fuflicient, ber caufe it might have contain'd and fecur'd the fame againft external Violence ; bat on the other hand, there occur'd an Inconvenience which mult be provented, namely, that the Body would remain 25 immoreable as if a Stake were run thro' it, and be entricly difabled from bending it felf in any manner

And again, if Joynts had been mad: in this Tube that includes the fponal Marrow, fuch as are in the Elbow, Fingers, © cr. the following Inconveniencies would have happen'd.

Firf, That the Parts of this Tube making fimall Angles with each other, or being eatirely bent down towards one anorher, the Medulia Spinatis muft have followed fuch an Inflection, and the Courfe of
he reervous Juice would have been obftructed by heic acute Angles ; which of how great Confeequience it is, is well known te thofe, who by the ike Obftructions have not only fallen into Lameiefs, but even Agues, Putrefaction and Rottenefs of the Bones, and have loft their Lives too thereby.

Secoidly, Tho' none of thefe Irconveniencies hould happen, yet the Body might by fuch fort bt Joynts be bended furwards, and in fome manner packwards too, but by no Means fide-ways; as is plain in the Elbow and Fingers.

Indeed, if Articulations were to be made like :hofe of the Shoulder or Hip; and that the Or $R_{0-}$ undum, or Knob of one Tube, flould turn or be moved in the Cavity of the other, it is eafy to fee that the Irflection would happen on all Sides: But it is likewife true, that the fpinal Marrow could not fuffer more in any Difpofition; forafmuch as being obliged to run thro' the Thicknefs of fuch a Bone, it could not avoid being fraiten'd and preffed by the Motion thereof, and foon render'd unfit for its Ufes.

To prevent all thefe Inconveniencies, and to render the Body flexible on all. Sides, and yet to avoid fuch Conftriction of the Medulia Spinatis, by making fome little Angles; and chichly to fecure the fame quite round, againft all Occurrences, let the molt skilful Engincer, or the greateft Mathematiciaa, confider with himfelf, whether he could better folve this important Probiem in Mechanics, and attain all thefe Ends by a more perfect Seructure than that which the adorable Wifdom of the great Creator does here fer before us. Thofe who defire a fhort Conception thereof, let them view Tab. IX. Fig. I. where the Back-Bone is reprefented, confifung of a Number of little Vertebra placed upon one another; each of which has a great Hole in the Midd!e, in order to ler the all of them togetier compofe a hollow Tubr from Top to Bottom ; which being inflected, ei ther right forwards or on either Side, do, by rea fon of the fmallnefs of the faid Vertebra, fcarce make any Angles, or very little ones: In the fam Manner as it were, as in the multangular Figure A E B, F, C, G, D, (Tab. IX. Fig. 2.) in which we fee little and infenfible Flections, where if the Sides were made a little fmaller ; or, if inftead of A E, two or more other Sides were taken, the Figure would be very near circular; that is to fay, without any Angles at all, at leaf, any that are perceptible to us..

Now, fince it appears from hence, that if we infrribe a Polygone in a Circle of fewer and greater Sides, as AB, BC, CD, the Anglet A BC, BC.D , $\sigma$ c. are much lefs and more acute than the Angles AEB, EBF, $\mathcal{O}_{\mathrm{c}}$, which are made when the Circumference of the Polygone Figures confifts of more and fmaller Parts: We fee likewife, that to prevent fuch acute Angles, it was here neceffary; that the Vertebra fhould be very fmall, and therefore very numerous.
Sect. IV. The Ufes of this Structure of the Back-Bone.

Now can any ore imagine that the Divifion of this Tube into fuch fmall Parts as thofe of each Vertebra (which was juft neceffary in this Place and no where elfe) could have been made only here, and in no other Parts of the Body, without the wife and premeditated Purpofes of a great Creator ?

Moreover, becaufe this Back-Bone was not to be moved by Joynts, but inflected without Angles, we fee in the Figare above-mentioned, how this is moft regularly brought about, by taftening each
ertebrit to the next above and beneath it by an inorvening Cartilage ; from whence the three folowing and fo neceflary Ufes do refult:

1. That by the Intervention of fuch a Cartilage, he Vertebre are hinder'd from rubbing and wearing put each orher.
2. Forafmuch as in the bending the Back-Bone on the right Side for Inftance) the Vertebre on the ame Side muft be brought nearer to each other, and upon the left and oppofite Side at the fame ime mult recede farther from each orher: That his Cartilage has fuch a Faculty as to be able to erve for both Purpofes, and to permit that the 3ack-Bone, by the mutual Approach of the Verebre at the Times of bowing or bending on the ight Side, are preffed fomething clofer together, ind fo render'd as it were thinner; and at the fame ime on the left Side proportionably extended, and oo became as it were thicker.
3. And that which is particularly required here, Is, that this Cartilage fhould likewife have an Elaer or expanfive Faculty, which, upon its being comprefleci on the right Side, fhould caufe it to rife ip again; and when extended on the left Side, hould likewife contract, or draw it in again.

Thus this Cartilage is not only proper to render the Inflection of the Back-Bone ealy and convenient ; but likewife to exert itfelf with a fenfible Force for the Reduction of the fame into its natural State after Inflection: The greatelt Mathematicians having enquired into this with the utmoft $\mathrm{Di}_{\mathrm{i}}$ ligence, have been obliged to acknowledge it for a wonderful picce of Work. Borelli, Par. 58. De motu Animalium calls it Artificium Struitura Spine Dorff, or the A tificial Strut:ture of th: Back-Bone, and begins his Enquiry by afcribing thefe and fuch like Matters, to the Wifdoin of the divine Archi$t \in[\%$.

I know very weil that in the Difpute with A theifts, Authorities are of little Force towards thei Conviction. Yet when we hear great Men, who have not this View direchly in writing their Books feaking after the fame Manner, it is very proba: ble that this can be afcribed to nothing elfe but the irreliftible Convictions of their Confcience wherefore it fhould feem that an unhappy Atheift if Reafon or Juftice may have any Afcendency o. ver him, might be fo far influenced thereby as to enquire diligently and ferioufly into that which has made fuch an Impreffion upon great Minds; and then confider with himfelf whether it be not rather the want of Examination and of Judgment than ftrong Arguments that has given him Occafion to differ fo much from the Sentiments of the moft learned Mathematicians.

And this is the End we propofe to our felves in writing thefe Contemplations; in Hopes that it may pleafe the great and wife Architect of all Things, to have Compaffion on them, and not to leave them under this terrible Curfe of obftinately rejecting the Examination of what the Confeffion of a divine Being will demonftrate to them, and of remair ing under a judicial Blindnefs, when nothing is wanting on their own Part but to open their Eyes.

> Sect. V. The Whirl-Bones.

We fhall pafs by the Wonders that might be obferved in the Eminences or Heads of the Vertebra, into which the Mufcles are inferted for Motion ; and in the Holes that are therein for a Paf fage for the Blood-Veffels; as likewife the Cavities that are between every two Vertebra, and thro' which the Nerves that are derived from the M.dulla Spinulis, pafs to their refpective Parts; the leaft of all which may furnifh tis with fufficiMatter of Allonifiment at the wife Defigns of the Creator.

Particularly the Structure of the two bigheft Vertebra of the Neck is very wonderful, which, bezaufe the cafe does here require it, and to the end that the Motion of the Head may not be obftruted, are each of 'em of a different Figure ; and he fecond of 'em has an Eminence which ferves for a Pin, upon which the Head may turn by the means of the firft Vertebra. He that defires to be Farther inftructed herein, may confult the Books of Anatomy which are in every one's Hand; and, if he be in earneft in his Enquiry into the Glory and Greatnefs of his Creator, make the right ufe hereof.

## Sect. VI. The Ribs.

Nor to dwell too long upon the ufe of the Ribs, which form the Space and Cavity of the Breaft, in order to leave room enough for the Heart and Lungs to move in, and at the fame ime to defend the latter from all External Violence: Let any one ask himfelf, whether it be pwing to mere Cbance, that thefe Kibs, in the pare where they are faften'd to the Cartilaginous BreaftBone, are likewife compofed of a Cartilaginous Subftance, to the end, that when they move at Refpiration or drawing-in of the Breath, they may be more eafily inflected by the Mufcles; and, after that the Operation of the Mufcle ceafes, they may, by their own Elaftick Force, return to their former Srate, and thereby contribute very much towards Breathing.

Concerning their Power and Action, you may fee what the Learned Borelli has faid in his Second Part.

## S ect. VII. The Hip-Bones.

To mention curforily the reft of the Bones, and particularly the Hip-Bones, with whofe moft ne ceffary Service we fhould be fufficiently paid, i they were of no other ufe only, than to fecure ant ftrengthen the Wombs of Women, from whencall Mankind receive their Birth; befides, that the: afford both to Men and Women an immoveabla Fulcrum, or Support, to the Thighs, Legs and Fee in bearing the whole Body: It fhould feem there fore that nothing remains, but to give fome ac count of the Siructure of the Arms and Legs, which, as alfo of their Articulations and Joints fomething has been already faid in our Contempla tion of the Mufcles, fince it was impoffible to treat o thefe laft with any manner of Clearnefs, withous fome knowledge of the former, to which there fore, if any one thinks it neceflary, he may have recourfe.

> Sect. VIII. The Tbigh-Bone.

Let then a Philofopher that is enquiring after Truch, take into his Hands fuch a Thigh-Bone a: we have defcribed (Tab. IX. Fig. 3.) $A E$, and fuct as he may have met with many times in Church. Yards and Charnel-Houfes, without taking any notice thereof, and he may fee in this alone, the great Creator's wonderful Direction to fo many neceffary Ufes. For he will find, firt, that the fame is very hard and ftiff to enable it to bear the Body; but at the fame time hollow, that it may not incumber the Morion thereof by it's Weight; and at the fame time to be provided with a Marrow, that is fo neceffary, and to keep it ready for the Service which it is to perform, of which hereafrer.

Secondly, That (in Tab.IX. Fig. 4.) the Knob or Head of the Bone $A$ is round, and is fo accurately adapted to the Os IJchii, or Hip-Bone B, that it can urn round therein, and be moved on all fides.
Thirdly, To give fome llight Defcription of this foint, fince the Figure will help us therein; can we difcover no Wifdom in the following Particuars? viz. Firft, this Knob $A$ is furrounded with a sind of a fmooth polifhed Cartilage, to the end hat is may perform it's Motion without Refiftance and without Pain. Secondly, that to give the greatar Steadinefs to the Joint, this round Bone $A$, is faten'd in the Cavity as it were with a Rope or Tenlon, by a Strong band $b$, which however does not ibftruct it's Motion. And Laftly, that a broad Band, , furrounding the whole Joint (but which in this igure is reprefented as cut thorough) ties the whole together, flill preferving the Freedom of Motion.
Fourtbly, To proceed in the Contemplation of he aforelaid Thigh-Bone (Tab.1X. Fig. 3.) it has wo Eminences or Heads, $D D$, at che place where t makes a Joint with the Leg or Shin- Bone below t the Knee; which are both likewife encompaffed vith Cartilages, that they may flip the more coneniently and fmoorhly. Thefe two Heads, $D D_{\text {, }}$ ir $b b$, (in Tab. IX. Fig. 5.) have between them a recty deep Hollow or Groove e, and are both dapted to two Cavities cc, which are above in he Shin-Bone $K$; and that again has an Eminence ying between the two Holes cc, which is likevife adapted, and enters into the internal Angle e, ,etween the Heads of the Thigh-Bone bb. Now, ieed we fay any more to prove very evidently the Jefigns of the Divine Archirea! And he who in ny wife comprehends it, muft he not be conviaced hat this Joint is of a different Seructure than that f the Thigh-Bone; and that it ought to be fo, $\mathrm{P}_{2}$ for-

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forafmuch as the Knee is only to be bent forwar and backwards, but by no means fidewife, as th Thigh- Bone, and rhat otherwife it would produc a verv irregular Gate?

Fifflly, To fay nothing of the Ligaments c Bands, which (as in the Joint of the Thigh wid the Hip borie) preferve all this from disjointing Nor likewife of the Knee-pan, the ufe of whic is beft known to chem who, having broken th fame by any Milchance, are thereby deprived 6 the chiefeft Strength of this Juint.

Could any one fee thac the little round Bodies. and C (Iab. IX. Fig. 3.) are of fo great ufe for th Infertion of the I endons of the Principal Mufcle: and fill fuppofe that this Bone had acquired it Form without Defign: In which, not one Emi nence, not one internal Angle is to be found, which if it had been of a different Structure, might no have occafion'd remarkable Inconveniencies it Men?

If any Body would fee the manner of fuch Structure at his Eafe, he need only confider thi Cliw and Leg of a Pullet, and that to which it i faflerid at both Ends, where he will find fomething very analogous to what we have now defcribed And let hin, who reflects upon all there Thing with $\mathrm{c}+\mathrm{re}$ and attention, judge whether it be no as reafunabie to acknowledge the wifdom of the Arcificer in this cale, as he would ào in any othet Machine made of Brafs or orher Metals? Which, tho'st would not be near fo ferviceable to living Creatures, yet would meet with lefs contradiction from this fort of Philofophers.

That the latter is crue, is well known to fuch as converfe with them; but however, it can't be deny'd that it is very ftrange and unaccountable, that they fould own a greater Wifdom in a meaner, and lefis Artful Machine, and yet deny it in a better.

SECT.

Sect. IX. Tbe Teeth.
To the above mentioned account of Bones, we night have added the particular Properties of thofe whereof the Teeth are compounded, and how they liffer from other Bones, to the end rhey may be he better adapted to their own Ufes. Now in cafe they had been produced by Chance, or by Caufes operating without Uiderftanding, why are hefe Bones exactly endow'd with the different Qualities which they themfelves required! And why do they fo feldom appear in the Moutns of Young Children in the firft Montis, when they Nould be both inconvenient to the Suckirg Child and Painful to the Mother? And why are they roduced at the time when the Stomachs of thofe Young Creatures are capable of digefting more olid Food?

Thofe who defire to bs informed of other Cirzumftances about the Teetn, may confult what as been faid above touching the Mourb, Cberving, \&:c.

SECT. X. The Bones in unborn Cbildren.
The Diligence of Anatomifts has difcover'd many Things in the Bones of Children before their Birth; and plainly flewn in feveral Cafes the difference there is "between thofe of one new Born, and of a Perfon in Years; yet it is fiill unknown of what Matter they are compofed at the Beginning, and afterwards in their Changes, till they have acquired their Solidity and true Naiure; and particularly, what were the real Caules of the whole.

So that no Body, who believes the Divine Origin of the Holy Scriptures, wi!! be furpuifed, that
the adorable Spirit of God, with which the W: ters thereof were endowed, has been pleafed $t$ make ufe of this Inftance, to prove the Smallne and Narrownefs of our Knowledge in thefe Mat ters, by the following Expreffions, Ecclef. xi. 5. A thou knoweft not wwhat is tbe whay of the Spivit, nor bo? the Bones do grezu in the Womb of ber that is with Cbild even So tbou knoweft not the Works of GOD who ma ketb all.

The Enquiries of the accurate Malpbigi, wher he treats of the wonderful Formation of the Bone of a Chicken in the Egg, are worthy to be con fulted upon this Occafion; but without going fi far, the few Obfervations that we have yet beet able to make in the Bodies of Men, do confirm ex perimentally, and plainly enough, thefe Words o Solomon; when we fee the Great Harvey, who is fo juftiy efteemed throughout the World, on accoun. of his famous Difcoveries, thus fpeaking in hi: Treatife de Ord. Part. in Generat. In the firft Montb fome of the Bones are Soft, otbers cartilaginous; the Arm So fhort, that wben laid upon the Breagt the Fingers cannot touch each otber; nor can tbe Legs, tho' folded upon. the Belly, Scarce reacb to the Navel: And this comes from bence, that the whole Fruit bus bardly tbe length of ibs Nail of one's Finger, till i: comes to be as big as a Frog or a Mouse.

At firft, tbere are formed little Fibres, or Tbreads, of the confiftency of slime, wbich are afterwards nervous, then cartilaginous, and finally of the bardnefs of a Bone. In the Second Montb (according to the feveral Experiments of the above-mention'd Author) the Embrio is very big in its Head, and very fhort in iss Legs; and the wwbole Matter So Soft and inconfiftent, that it can bardly bear touching witb the Hands; and in order to be examined, muft be laid in Water; wor is tibere any Solidity in she Boses.

Now will the moft felf-conceited Philofopher dare to maintain that he ever rightly knew, how the Bones of an Embryo are fram'd in the Womb? And if he is reafonable, muft he not be convinced that this Hypothefis is wifely chofen to fhew the fmalnefs of Human underftanding? And to the end, that it might convince not only the Philofophers of that Age, but likewife all that came after them, where their Knowledge is bounded and defective, and that it fhould continue $\mathrm{fo}_{0}$ in fpite of all their greedy and reftlefs Scrutinies: Muft he not own that the State of Things, and the Limits of Human Sciences, even to the lateft Generations, were not lefs known to the great Infpirer of this Holy Word; and confequently that he who fpake ir, muft be more than a Man; yea, that he could be no other but God, to whom only all future Events are clear and manifeft?

## SECT. XI. The Bones are produced from a fluid Matter.

Before we proceed farther, let the Reader confider with himfelf, whether it can be thought, that an Over-ruling Power and Providence had no flare in this Matter, when he fees hard Bones fo wonderfully adapted to many Ufes, arifing only from a Slimy Matter, which owed it's beginning to nothing but Bread and Water?

For that the Bones, be they never fo hard, do in a great manner arife out of a Fluid, is abundantly proved by the Chymifts, who, having diftilled the fame quite dry, and without the addition of any Liquid Matter, do produce from thence a great Quantity of Oyl, and yet more of Watry Parts (in which their Volatile Salt is melred, and which therefore is called their Spirit) as is well known to fuch as have made the Experiment.

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\text { P } 4 \quad S E C T \text {. }
$$

## SECT. XII. P $\int a l m$ CIX. ver. I8.

Now with how precife a Knowledge the Hol Ghoft has fpokèn in other Places of Scripture, eve of this internal Structure of the Bones, will apper as plain as the Sun at Noon, to fuch as from Ch rurgical Experiments have learnt, that there is no thing more pernicious to a naked Bone, than t put Oyl or any other Moifture upon it, which wi caufe a miferable Corruption therein: On whic account it is, that the moft skilful Surgeons, i treating about the Difeafes of the Bones, do mo: carefully warn their Readers againft the fame.

For an Inftance hereof, one need only read th Words of Hildanus; $A b$ omnibus autem bumidis o ole aginofis in denudatis ofjibus in quacunque corporis parte plané ut abftineat Cbirurgus neceffe eft. P. 816. That is $t$ fay, a Surgeon muft carefully abftain from the ufe of ar Moift and Oyly.Matters in the managing of naked Bones in wwhatever part of the Body they lie. As alfo Mr. Par, fays, upon the fame occafion, p. 560. Moreover th Bones may be likeswife Corrupted by the improper Applica tion of any Oyls, or other Liquid Medicines.

I have only produced the Evidence of thefe two Gentemen here, becaufe they may be juftly rankei among the moft Famous and Skilful Men in thit Art.

For to return to the Matter again; Can any one that reads that Text, in Pf.cix. ver. 18. As be cloathed bimfelf withb Cur ing, like as with bis Garment: Jo let it come into bis Bozvels as Water, and like Ojl into bis Bones; and who has ever feen this Caries Offum, or Corruption of the Bones; in any other conliderable degree in a living Perfon, and has been informed that the fame may be produced, or at leaft augmented, by any Liquid or Oleaginous Matters, muft needs confefs, that the Wrath and Curfe of

God cannot be defcribed by more lively Comparifons, fince Water and Oyl, that are mentioned in this Text, are both of 'em the moft pernicious Things imaginable to the Bones.

## Sect. XIII. Bones without Nerves.

According to the very Learned Anatomift, Mr. Verbeyen, the Bones having no Feeling, are confequently without Nerves, which are accounted by all as the Inftruments of Senfation; but whether that be produced by their Marrouv, Fuice, or Membranes, we fhall not here contend: The fame is not obfcurely maintained by a famous, Englifh Anatomift, Dr. Clopton Havers, who, tho' he differs a little from the former, touching the feeling of the Bones; yet, in his Ofteologia Nova, or New Defcription of Bones, p. 29. he affirms, that having enquired as nicely as poffible inno this Matter, he could difcover no Nerves in the Bones; but endeavours to fhew how this want of the Nerves may be fupplied; fo again, fpeaking of the Nerves of the Teeth, P. 102. he fays, that there be other Bones to which it Should Seem that no Nerves do belong.

## Sect. XIV. Marrow.

Before we conclude thefe Remarks concerning the Bones, we muft fay a word or two about the Marrow: Now can any one fuppofe that the Bones were made hollow without Defign, fincethey ferve for the Receptacles of a Fat or Oleaginous Matter, which tenders the Limbs fmooth, and fupple in their Motions, and prevents the Cartilages in the Joints, when fliding upon each other, from being worn out or burnt by a continual Attrition, which wou'd happen if they fhou'd remain dry, as appears by the Axel trees of Wag-
gons and Mills, which are greafed for that very purpofe?

Not to mention here, that by the faid Marrow. the Bones themfelves (which being otherwife tod dry, would become brittle) and the Ligaments on little Bands thereof are kept in their proper Condition by fuch a Moifture ; as we fee the Muficians oyl the Strings of their Inftruments, to the end that they may not break by too much Drynefs.

How plainly then does the Wifdom of the Great Creator fhine forth in this very Matter, by contriving, in fo hard a Subftance as Bones are, Ducts and Paffages thro' which the Marrow may ooze out or filtrate from the little Tubes of the Bones into the Joints?

> S e C T. XV. Water and Oyl togetber. Serve to render the Parts fmootb.

They that deal with Air-Pumps (the Conftruetion of which, to render the matter more intelligible to unexperienced Perfons, muft be fuppofed to be like a great Syringe) know, that the Sucker thereof muft be firft fteep'd in Water, to make it fwell out to the neceffary Thicknefs and Softnefs; after which it is oyled a little, that it may move backwards and forwards more fmoothly and readily; from hence it is plain, that when the Sucker, cumified with Water, is chruft with fome Force into the Tube of the Air-Pump, which is narrower than the extended Sucker, the Water is preffed out and mingles itfelf with the Oyl that was fmeared over the Sucker.

Now could any Body, who has never made a trial thereof (co add fomething here which is very remarkable) imagine, that Water and Oyl thus mix, ed together, are much more proper than Oyl alone, to caufe two Bodies, rubbing againft each orher, ther? And yet, that this is true, the aforefaid Experiment has taught us; wherefore, it is likewife very ufeful, that the Sucker, already fmeared with Oyl, fhould be even once again dipt in Water, before it be thruft into the Tube of the Air-Pump.

The firft Obferver hereof, was the great Mr. Robert Boyle, who, upon the account of his Enquiries into the Creatures, can never be fufficiently praifed; that Gentleman, in the Introduction to his Pbyjico-Mecbanical Experiments, p. 7. of the Cologn Edit. \peaks thus of this mixture of Water and Oyl, to render the Motion of his Air-Pump more eafie: Upon wbich occafion we muft not bere omit (becaufe it appears (o wonderful) that neitber Oyl nor Water ufed fingly; could bring to pafs that the Sucker fhould be moved eafily and readily; but that a mixture of them both (feveral times repeated to our great furprife) did produce the defired effect.

Thus we fee that a Gentleman, who, if he can't be called the greateft Philofopher in the World, yet may juftly be placed in the firft Clafs of Great Men, acknowledges himfelf, that he could never have difcovered this by Argumentation, but learnt it (to bis great furprife, which ought to be well obferved here) by Experience only.

SECT. XVI. Oyl and Water thus mingled, infinuate themselves into the Foints.

Now let the Atheif, that has never fo high an Opinion of his own Underftanding, or the ftrongeft Mind (as they love to call themfelves) ferioully confider by himfelf, laying afide all Obfinacy and Paffion, whether he can afcribe all this, with the leaft appearance of Reafon, to meer Cbance, or ignorant Caufes; when he fees with his own Eyes, that, in order to render the Joints more fupple and moveable,
able, and to produce fuch a mixture of Oyl and Water as would be fit for that purpofe, there ars found, in and near the faid Joints, perpetual Spring: and Fountains; out of fome of which there flow: a kind of Oyl of the Marrow, (of which mention has been made above) and from others a tough nimy Humour (which Dr. Havers, the Difcoveret thereof," calls the Mucilago) into the Joints, berween the two Cartilages that rub upon each other. And the faid Author fhews by Experience, that it is not without juft Caufe that he names them Watry Humours, becaufe he proves, that after the Evaporation of the Water, there does hardly remain the thirtieth Part of that Matter.

Once again, I fay, let fuch an unhappy Infidel betake himfelf to fome Recirement, where he need not be affected with the Shame of Recanting thofe Erroneous Opinions, which he has fo long and fo boldly maintained, and confider, whether he can believe, fince this Mucilaginous and Warry Humour is of $\mathrm{fo}_{0}$ great Service, that all this Apparatus of fo many Glands as are found in the Joints, and which, being compreffed by the Motion of the Bones, do, like iqueez'd Spunges, yield this Moifture ; 1 fay, whether fuch a Difpofition can be made withour any determinate End. And, on the contrary, whether he does not plainly difcover therein, the Wifdom and Defigns of the Creator.

As firt, that thefe Glands (fome of which being taken our of the Joint of tie Elbow, are of the Form reprefented in Tab. IX. Fig. 6. and others lying by the Knee-pan C, takén our of the Knee at $a$ a $a$, Fig. 7. with the Membrane $66 \dot{6} b$ ) placed in fuch a manner, as not to receive any Prejudice by the preffing of the Bones; for which purpofe, the Great Creator has prepared for chem a Cavity, which encompaffes and fecures them againft any rubbing or breaking in great Motions and other Cafes.

Cafes. Secondly, However in fuch a manner, that when there are great Inflections and much Work to be done by the Joints, they may be foftly compreffed to make them render their Liquor more freely, of which a greater Quantity is then wanted; and when the Joints are at reft, thefe Glands may preferve more of it in them, and not fhed it in vain. Thofe who defire a more exact Account hereof, founded upon feveral Experimental Difcoveries, may have recourfe to the above-mention'd Treatife, from pag. 227. to p. 232.

SECT: XVII. Convictions from the foregoing Observations.

Now how many Convictions of the Wifdom and Goodnefs of GoD, may be deduced from this Defcription of the Marrow, and Structure of the Glands, may be learned from the aforefaid Author, pag. 238. whofe Words are as follows; And bere we cannot forbear to obferve the vifible and palpable Tokens and Footfeps of an Infinite Reafon, whbich, as they are deeply engraven upon the Univerfe in general, are yet So in a much more particular manner in this wife Dijpofition of Motion in Animals. Nor can we ever Sufficiently admize the Wïjdom and Providence of our Great Creator, wibo has communicated to all the Parts of there Beings, not unly fuch a Compoficion, by which all the neceffary Motions and Operations, requifite in them, are conveniently produced; but has moreover endowed them with fucb Advantages and Privileges, whereby they can both maintain themfelves, and difcharge their proper Functions in the moof eafie manner.

CO.N:

## CONTEMPLATION XII.

## of the Sight.

Sect. I. Tranfution to the Sigbt.

WE proceed now to the External Senfes, and among them to obferve in the firft Place the Inftruments of Sight; where it muft needs ap. pear incredible to every one, that fuch a Number of Particulars and Circumftances, as are requifite in fo great a Matter as that of the Sight, fhould have concurred and met each other in fo fmall a Compafs as the Space that contains the Eye, by mere Chance, or neceffary Caufes, without the lealt View or Intention of the Creator.

To give therefore a Brief Account of the External Difpofition of the Eye : Can it be thought to happen without Defign?

## S ect. II. The External Structure of the Eye.

x. That becaufe the Eye is fo tender as to be hurt by the leaft Accident whatever, the Eye-lid may, like a Curtain, be drawn over it with unconceivable Swiftnefs upon the approach of any Danger, for the Security thereof; and at the time of Sleep, to hinder the Action of Light upon it to the breaking of that Reft which is fo neceffary to it. And again, that with the fame Swifnefs for the Admiffion of Light, the Eye lid can be lifted up and folded together, for which End it is provided with particular Mufcies.
2. To
2. To the end, that the Eye-lids may not hang loofe and flabby upon the Eyes, and that their Mocion may be the fwifter, they are provided with a Cartilaginous Bow, which is accurately and nicely adapted to the Convexity of the Eye.
3. That the Eye is encompaffed on all fides by Bones, to defend it from all outward Harms: Forafmuch as by the leaft preffure the Figure of it would be changed, and (not to mention the Pain or Smart) the Sight would be greatly diforder'd. If any body doubts of this, let a Man fhut one of his Eyes, and prefs the other gently with his Finger, and he will prefently be convinced of this Truth by the different Appearance of vifible Objects.
4. The Structure of the Eye-brows, which are provided with Hair, to prevent the defcending Sweat of the Forehead from running into the Eyes.
5. To the end that the external Membrane of the Eyes may not be dryed up, and wrinkled by the Air, and fo not only the Motions of the Eyelids, but likewife the Sight itfelf obftucted, that there are Glands placed in one Corner of the Eye, and over it, which by reveral little Tubes, fhed a continual Moifture upon the Eye, to make it fimooth, and to fecure the Membranes from too great a Drynefs.
6. And to the end that the Countenance fhould not always appear Weeping and cover'd with Tears, that there are Paffages contrived, by which this Humour at the ufual Times can be difcharged into the Noftrils. And the fame Humour in exeraordinary Occafions, being changed into a flood of Tears, we are then much more fenfible of the Courfe of them into the Noftrils.
7. To the end that we may not be obliged continually to turn the Head to different Objects, there are different Mufcles faften'd to the Eye, that in
an inftant of Time do fuffice to turn it on al Sides,
8. That no part of this Mufcular Structure Chouli be in vain, the Eye is made in a manner Globu lar, to turn indifferently in a Cavity adapted te it; the back Part of which is lined with Far, th render the Motion fmoother and quicker.

S E C T: III. Convictions from what bas been faid.
Ho w fmall foever thefe litte Circumftance: may appear to fome People, and as little beholder as an unhappy Philofopher may think himfelf te his Mafter, while he afcribes all to meer Chance or Ignorant Caufes; yet if he fhould happen to bt depriv'd of the ufe of any one of them, he would foon' be fenfible of the Inconveniences thereof: And tho' perhaps he might ftill continue fo obdurate, as not to own the Goodnefs of God in beftowing them; yet if he were not quite divefted of Reafon, he would be convinced, that he fhould owe a great many Thanks to any Body that reftored it to him, as foon as he felt the want thereof.

With much Compaffion as well as Aftonifhment at the Goodnefs of our Loving Creator, have I confider'd the fad State of a certain Gentleman, who, as to the reft, was in pretty good Health, but only wanted the ufe of thofe two little Mufcles that ferve to lift up the Eye-lid, and fo had almoft loft the ufe of his Sight, being forced, as long as this Defect lafted, to fhove up his Eye-lids, every moment, with his own Hands.

If it be owing to Chance that fuch fmall Mu fcles as thefe are fixed in thofe Parts: How comes it, fince fo many Things muft concur to their Motion, that we don't meet with fuch Defects in Millions of other Men? Since Chance does as eafily produce the one effect as the other; and fince there

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be Milions of Ways in which the Particles that compole the texture of fuch Mufcles might concur; amones which however, there would no be one that could difpofe and adapt them to fuch ufes.

Would an Atheift venture to affirm that the fimplo Pulies made ufe of tu raife Safh-windows, had acquired their Aptitude for that purpofe by meer Chance?

## Sect. IV. The Properties of Light.

If all this be not fufficient to convince the moft objurate Atheif, let him go on to contemplate with us that which follows, and we do not queftion, but he will be forced to own, that the moft fecret Laws of Opricks and Mathematicks muft have been known to him that formed the Eye, before He could have produced fuch a wonderful Machine.

Now it will be neceffary to thew fome of the Properties of Light, to fuch as are unexperienced in the aforefaid Sciences; to the End, that they may have a tolerably clear Conception chereof: It is therefore well known:

1. That the Light, either of the Sun or of a Candle K, (Tab. X. Fig. I.) to give an Example thereof) falling upon the exiream Part or Point of a Needle, renders the fame vifible to an Eye at C C C , Cuc. and $R$, wherever it be. So that it appears from thence, that the Light diffufes its Beams, P C, P C, oc. Sphterically, or like a round Ball towards all fides; and therefore, that in the whole upper Superficies of the faid Ball, as $C, C, C, R, \notin c$. no Point can te taken, to which fome Ray, as PC, is not extentite, fuppofing the Eye at any of the Points, $C, C_{2}, C, O C$, or where-ever elfe it is placed in that sphere.

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And that this is each time performed in a ftrai line, may be obferved from hence, that a dar, Body $S$, placed between the Eye at $R$, and th Point $P$, in the Right Line $P R$, hinders the Ey from feeing the faid Point $P$.
2. This continual Scattering or Separation of th Rays, P C, P C, \&cc. from each other, is called Di verging: And thus we fee, that all the Rays of Ligh $P C, \dot{P} C$, ofc. with refpect to one another, when they proceed from the faid Point $P$, are what thi Learned call Divergent; as on the contrary, thof Rays, for inftance, that flow from feveral Point: $C C, \dot{O} c$. and by the help of Burning-Glaffes, o other Optical Methods, are compelled to run int a Point $P$, are called Convergent.
3. It follows from this Divergency (Tab. X Fig. 3.) that if from all the Points, as $A, N, L, M$ $B$, of the Line $A B$, (or rather from fo many a there may be in the whole Line $A B$ ) the Rays fal upon another Line $S T$; the Rays flowing fron all the Points of $A B$, to each and fingular Point o the Line ST, cannor be extended without, an ap parently great Confufion.
4. Wherefore, in cafe the Rays Diverging afte this manner, fhould fall directly upon that Part o the Eye where the Sight is to be formed, the Ray proceeding from each Point of the vifible ObjeE $A B$, would fufficiently fill the whole Superficies o the Place, and fall into great Confufion among one another, as may be feen at $S, T, O$.
5. Now 'tis a known Law of Opricks, that ir order to fee an Object diftinctly, all the Ray: coming from a Point thereof (as from $B$ for inftance) mult be collected at the Bottom of the Eye in a Point $b$ (and fo fuch as come from $A$, and other Points of the faid Object, in fo many other Points again, as $a, \notin c$.) thus forming upon the Bottom of the Eye at $a b$, the Picture or Image
of the Object $A B$; but inverted, or upfide down.
6. Now fince this cannot happen unlefs the Rays, which, according to the Natural Courfe of Light, proceed from the Point $B$ divergently, or wider from each other, are again made Convergent at the Point $b$, it has pleafed the Great Creator to determine the Motion of Light, with refpect to the Medium, or Matter thro' which it paffes, by other Laws, by which He brings this great End to pafs.

Sect. V. Concerning Refraction or Breaking of the Rays.

These Laws are thofe which in Opticksare known by the Name of Refraction (that is the breaking, or rather the bending of the Rays of Light) and the Appearances thereof are as follows;

1. When Rays pafs from one Medium or Tranfparent Matter, fuch as the Air, for inftance, into another, as Water, Glafs, Chryftal and the like, whether it be denfer or rarer.
2. When they fall upon the latter with any Obliquity ; for if they fall at Right Angles, or Perpendicularly, We find they pafs directly through, and are not broken, or bent at all.

SEC T. VI. An Experiment of Rays paffing from Air into Water.

If you defire to fee this experimentally, fet a Candle in a dark Room (Tab. X. Fig. 2.) upon a Table, and an empty white Bafon NKLM, at a little Diftance from it, in fuch a manner that the Shadow of the Brim M L, of this Bafon, may extend itfelf from $M$ to $D$; when it will appear, that the Ray $A M D$, which feparates the Shadow at $D$ from the Light, is the laft Ray that Q2 falls
falls on the enlighten'd inward Part of the Bafon place $N B D$.

Then lay a mining piece of Money $E$ (for in ftance a Shilling) juft within the Shade, fo that the Edge of is may approach very near to $D$; you muft take care next to fix that piece of Money in fuch a manner, that it may not remove from ites Place; and laftly, fill the Bafon up to $B C$ with Water; then you will find that the Shadow will not extend itfelf farther than to $F$, and the Shit ling sill lye out of it in a perfect Light: Se that now HF is the laft Ray that feparates the Light from the Shadow.

Now it is plain, that from $A$ to $F$ there can onme no direat Ray A $F$, becaufe it is fopt by the Bafon at $P$.

And yet you fee the Light proceeding from $A$ to $F$.

From whence it follows, that as the Ray moved direaty in the Air from $A$ to $H$, inftead of proceeding ftrait forwards to $D$, it is broken and bent, and makes an Angle $A H F$, at the Superficies of the Water $H$, and fo runs from $H$ to $F$.

And thus you have an Example, how a Ray AH, pafling thro' a thinner Medium, fuch as Air, into a thicker, as Water, is Refracted or Broken; and in fuch a manner as to bend cowards the Perpendicular Line GH Q, which makes a Right Angle upon the Superficies $B C$, where the different Mediums of Air and Water are feparated from each other.

SECT. VII. An Experiment of the Refraction of Rays pasing from Water into Air.

Now to fhew the Appearances of a Ray paffing from a denfer or thicker Medium, to a rater or thinner, as from Water to Air:

Iay the fiid Shilling $E$, in an empty Veffel $N K$ $L M$, (Tab. X. Fig. 4.) fo that one who ftands at $A S$, may be juit hinder'd by the Brim of the Veffel I $M$, from feeing the Money at $E$ : Forafmuch as from E to the Eye $A$, no direct Ray $A E$ can proceed, by reafon of the Interpofition of the faid Brinz M L.

Then fixing the piece of Money E, to the Bottom of the Veffel in fuch a manner, that it may not be removed by pouting in the Water, let there be Water poured into the Veffel as high as BC: Whereupon he that ftood at $A S$, and could not fee the Shilling bifore, will perceive it very clearly, as if it was at $F$.

Now it is plain from all this, that the Money realiy lay ai $E$, and that it could not be feen by any direct Ray EA.

And yet if was clearly feen at $F$.
From whence it follows, that it muft have been feen by the Refraction, or bending of the Ray $E H$, which, inftead of running directly to $T$, makes the Angle E $H A$, and fo reaches the Eye $A$.

Which (becaufe we are wont to imagine that we fee nothing but what lies in a right Line, extended from our Eye to the Object) fees this piece of Money as if it lay at $F$.

And to prove that it on! y happens thus by the aforefaid Refraction, let another Perfon be placed at I O, whofe Eye $I$, is not able to fee the Money $E$, while it lies in the empty Veffel, the Rim of which, $N K$, intercepts the direct Ray IE; and yet when the Water is poured into it, he will fee the fame lying at $P$, by the help of the Ray ERI, sefrated at $R$ : So that the fitid Moncy will appear to the Eye $A$, removed from $E$ to $F$, but to the Eye I, removed from E to $P$; and thus two Coneradictory Motions will be produced: And in like manner, if there were a whole ring of Spectators a- a different Place.

From hence it appears, that a Ray, $E H$, is re fracted in paffing from a denfer Body, as from Water, into a rarer, as Air; and that it does not run directly from $H$ to $T$, but to $A$, and fo is fomewhat inflected from the Perpendicular Line G H Q.

Sect. VIII. An Experiment hewsing tbat Rays falling at Rigbt Angles are not Refracted.

I t is likewife plain, that a Ray falling perpendicularly from one Tranfparent Medium to another, fuffers no Refraction, (as the afore-mention'd Ray did, which came upon it obliquely) if you look upon the aforefaid piece of Money E, lying in an empty Veffel, thro' a Narrow and Perpendicular Tube $D V$, whilft it lies directly únder it; after which, fill the faid Veffel, with Water up to $B C$, taking care that the Money remain in the fame Place, and the Tube in the faid Pofition, thro' which the Money will be feen juft as it was before. Whereas, if you look at it thro' the Tube lying obliquely in the Pofition $H T$, the Money will not be feen at $E$, as in the empty Veffel; formuch as, in order to fee it again after the Water is poured into the Veffel, the Tube muft be brought down from $H$ T to $H A$, by reafon of the Refraction of the Rays: This is what every one may try, as well as we.

SECT. IX. Divergent Rays made Convergent, and form an inverted Image.

From thefe two Laws there does now follow a General Rule, which, as appears by innumerable Experiments, is always obfervable in the Motion of the Light, viz. that (Tab.-XI. Fig. I.) the Rays

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$H, B H$, Diverging from a Point $B$, may, by Reaction, be inflected towards each other, and beome again Convergent in a Point $b$.
I. When they pafs from a rarer Body into a denir, which is Convex and Spherical; and, 2. When ley fall upon an Object of the like Figure, from thicker to a thinner Medium.
For inftance, let $K F$ be a Glafs polifh'd on both jes, and each fide of $K M F$ and $K N F$ be Conex and Spherical: Now when the Ray $B H$ comes pon it from the Air, it will not proceed to $R$, but 3 inflected towards the Perpendicular $G H$, and ke its way according to $H P$; but in paffing from he faid Glafs $P$, into the Air, it will not proceed , $S$, according to $H P$, but receding from the Perendicular Line $P Q$, purfue its way to $b$.
And this happening to all the Rays, which fall om $B$ upon the Glafs between $H H$, they will all $\because$ united again about the fame place at $b$, only the liddle Ray, $B M N b$, becaufe it falls every time erpendicularly upon the Glafs, runs directly for'ard, and without being refracted.
So that in cafe we fuppofe (Tab. X. Fig. 3.) that : ST, a Glafs is fo placed, as that the Rays paffing om $A$ to $a$, from $B$ to $b$, and from the other Points $T, L, M$, to $n, l, m$, be united together, they will lake at $b a$ an inverted Image $A B$.

## SECT. X. An Experiment Shewing the Same.

Ler thofe who have a mind to fee a very eafie ixperiment hereof, place one fingle Candle in a Shamber at Night, and retiring fome Diftance rom it, let them caufe its Light to pafs thro' a pectacle Glafs upon a white Paper: Whereupon, laving likewife adjufted the Diftance between the fials and the Paper, they will fee the exact Piture of a Candle inverted upon the faid Paper.

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That is, at the place $b a$, where all the Ray coming from each of the Points of the Candle, al $A B$, are collected in fo many other Points by the two Refractions, which (as in Tab. XI. Fig. i.) they fuffer thro' the Spectacle or Burning-Glafs, convex on botin fides, and fo form the above-mention'd Image.

## Sect. XI. A Second Experiment in a dark Cbamber.

THFRE is another way of proving the fame by the famous Experiment of a dark Chamber, which is made thus: You muft make the Chamber as dark as you can, leaving a round Hole in a Window, fomething fmaller than the Circumference of a Spectacle Glafs; then place fuch a Glafs exactly before the Hole, taking care that the Light has no other Daffage into the Room.

Now if you hang a white Cloth or Paper at a proper diftance before the faid Glafs, fo that the Rays that proceed from every Point of the Objects may each of them be collected in its correfpondene Point, you will perceive that the images of every Thisg that is without the Chamber will be painted in the moft perfect manner, upon the faid Cloth or Paper, according to all its Libeaments and Colours, efpecially if the Sun happen to thine upon the External Objects, and the Glals be in the Shade; as it may when, for inftance, the Sun is in the South, and the Window, in which the Glafs is, flands towards the North, fo that none of the Sun's Rays come direatly upon i..

## SECT. XII. Convictions from the foregoing Objervations.

Now fince it is the Property of Rays that proceed from a Point, to be diverged and fcattered
from each orher, and that they muf be made to converge of be unired in a Point again, in order to form the Pictire of an Object, and thereby to make us fee it diftinctly: Can it be conceived that all the fe Laws concerning Light, all this Difpofivion made in the Eye (how fmall foever it may appear to an Ignorant Perfon) and all the other neceffary Circumfances obferved therein; I fay, can is be thought shat all thefe Things have concurred in fo little a fpace, as that wherein the Eye is piaced, without any Defign or Wifdom of the Creator?

## SECT. XIII. The Eye is a Dark Cbamber.

Now to reprefent this Matter to every one's entire Satisfaction, and to convince him, that the Images of vifible Objects are really painted upon the Botron of the Eye by the Lighr, after the fame manner as in the above-mention'd dark Chamber by a Convex Glafs; He need only take (thus I find the Experiment to have been made in the Year 1696.) the Eye of a newly killed Ox, while it is warm, (fee Tab. XI. Fig. 2. C G E H) afrer having divefted it of its Flefh and Fat, and lefe nothing remaining but the Membranes and Optick Nerve; then about $b$ or $a$, behind in the Eye, let there be a fmall hole made with the point of a fharp Knife, in the Membrane in which it is involved; and moreover a little found piece, of about a Finger's breadth, cut out with fine-pointed Sciflors, leaving it faften'd only at $X$, fo chat the Eye may be hold by the Part here reprefented at $X t$, and fo the Orifice CCN directed which way one pleares.

Then placing the Flame of one Candle only, lighted for that purpofe in a dark Room, before the Eye at $A B$, you fhall fee the exact Picture of the fame, inverced very plainly at $a b$, and reprefinted burning upfile down.

But that this Experiment may be made as it ought to be, care fhould be taken not to hurt a very fine and tender Membrane, including the Vi treous Humour behind at $a b$ : For whereas you otherwife fee the faid Humour itfelf tranfparent and naked, fome Light may perhaps appear, but the Image will not be fo well reprefented.

However, upon fuch an Occafion, which eafily happens, one may cover the naked Vitreous Humour behind at $a b$, with a very fine white Paper; by which means you will fee the exact Form and Motion of the Flame, and alfo the Top of the Candle itfelf, accurately drawn upon it.

It is more convenient to try the Experiment after this manner, than to place the Eye before the Hole of a dark Chamber, in order to admit thereby the Images of the External Objects: It is likewife performed this way with much lefs trouble.

For one may eafily fee this way, I. That the Eye being brought nearer to the Candle, the Picture is drawn fenfibly larger; and if removed farther from it, it becomes fmaller again. 2. That upon moving the Candle towards the Right, or Left Hand, the Picture goes in a direct contrary Motion.

From whence it feems probable, that our great Creator makes ufe of thefe Means, to the end, that by increafing, or leffening the Images formed in the Eye, we may judge of the Diftance of Objects by their apparent Greatnefs, or of their Greatnefs by their apparent Diftance; as He likewife makes known to us the Motion of Things that are remote from us, by the Motion of their Images.

For that thefe Images are not formed in the Eye, without making fome Impreffion upon the Membranes thereof, feems deducible from what a Man feels, who has been any time in the Dark, when he fuddenly returns into a great Light, and opens his Eyes to look about him.

Having thus far thewn that our Eye is a real dark Chamber, this Truth does likewife occur to us, namely, that fuch Images of an Object $A B$, cannot be formed upon the Bottom of the Eye at ab, by Rays, which, for inftance, flow from the Point $B$, fo long as they are Divergent, as at $B C$, $B C$; but that it is abfolutely neceffary for that purpofe, that they fhould be bent again towards each other by Refraction, in order to be collected into a Point $b$, and there to form the Image.

Sect. XV. The Tranfparency of the Tunica Cornea.
Now to reprefent only fome few of thofe Circumftances, which may ferve for Conviction, without embarrafling a Reader not well skilled in Anatomy with a Number of differing Names given by the Learned to the Membranes of the Eye, of which fome Anatomifts reckon only three, others 4, 5, 6, 7 , yea, 8 and 9 , as you may fee in Verbeyen; Let us fuppofe the little Globular Body, GCHE (Tab. XI. Fig. 2.) to be the Eye.

Now no Body will conteft with us,
Firft, That in eafe all the Membranes which encompals the Eye were opaque, as well as thofe that are in the other Parts of the Body, by reafon of their want of Tranfparency ; the Light would be able to get little or no accefs to the Eye.

Can it be then fuppofed to be without Defign, that notwithftanding that the whole Eye is encompaffed round about with an untranfparent Membrane GEH (which fhews iffelf likewife externally, as the White of the Eye) yet, at that place where the Light falls upon it, at NC C, there fhould be found a fpherical, thin, bright, and very tranfarent
rent Membiane, fuch as the cleareft Horn or Glafs is, in order to afford a Paflige to the Light; and which is therefore called che Tunica Cornea, or Horny Membrane?

## Sect. XVI. Tbe Aqueous Humour.

Secondly, Now in cafe the Rays of Light, BC, $B C$, coming out of the Air, and from the Point $B$ (for example) and having paifod thro' this Membrane GNCH, thould again meet with the fame Air placed in the Cavity of the Eye, GSDIH $C G$; as it happens in the Cavities of the Ear, where fuch Air is neceffary, they would proceed to diverge or feparate themfelves from each other, and fo be unable to form an Image at $b$, which is requifite in order to fee the Point $B$ diftinctly Will any one again pretend, that it is withont Wif dom and Defign, that this fpace GSDTHCG is filled with a Liquor that has all the neceffary Qualifications in it, viz. that it is, Firft, entirely Clear and Tranfparent for the Reception of Vifiom; Socondly, that it is thicker than Air, and about the Subftance of Water, for which reafon 'is called the Aquecus or Watry Humorr ; Thirdly, that it is convexty round, as appears by the external Figure of the Eye; from whence ic is plain, that both the Rays, $B C, B C$, divergent from $B$, cannot proceed forwaras to g g ; but by the Laws of Refraction, muft be inflected towards each other, and purfue their way to $D D$, according to the Lines $C D, C D$ ?

## Sect. XVII. Cbryjtalline Humour.

Tbirdly, Now if we hould fuppofe that there Rays, accorting to $C D, C D$, frould again proceed directiy to $\mathrm{da}^{3}$, we fiould at the fante time finl,
find, that they would either not at all run into a Point, or at leaft inte fuch a one as lies very far behind the Eye.

From whence it follows, that there munt be a new Refracion to inflec: them again towards each other, in order to make them meet at $b$, or in a much nearer Point.

Now, in order to make this happen very exactly, another Body, ST D E S, muft cone after; which is, firf, Tranfparent, fecondly, Thicker than the Aqueous Humour, and, thirdly, in fome meafure Convex.

And here again, we find all thefe required Circumftances to happen in fuch a manner; for the very opening of an Eye, may convince every Body, that the following Humour S TD E S, is not only clear, but likewife of a thicker Subftance than the Aqueous, for which reafon 'tis called the Cbryftalline, and reprefents rather a folid Body than a fluid, and, which is yet more, it is Convex at SDDT.

Thefe are therefore the Means that hinder the Rays proceeding, as $C D, C D$, from paffing on directly to $d d$, and force them, according to the Laws of Refraction, to inflect themfelves a fecond time towards each ocher, and to take their way to D E, DE.

S e c T. XVIII. The Vitreous Humour.
Fourtbly, Again, if thefe Rays had purfued their Courfe ftrait forwards to ee, they would indeed have met again at the Point $k$, but that would have been too far behind the Eye; and they falling upon the Botcom of the Eye, would have taken up too much room at $m n$; and the fingle Point of the Ob ject $B$, would have been here reprefented with a great superficies, $m \pi$, which happening thus thro'
all the Points of the Object $A B$, the Rays of fe veral different Points lying near each other, woulh have ftruck the Bottom of the Eye in the fam place, and fo have produced a confufed Image, and therefore confufed Vifion.

He that does not conceive this eafily, may repre. fent to himfelf, firf, wich a proper Exactnefs by the help of a Convex Glafs, placed at $S T$, in a dark Chamber, (Tab. X. Fig. 3.) the Picture $a b$, of an Object $A B$ upon a white Paper $r s$; and then removing the Paper from $r$ s to $p g$, or nearer to the Glafs S T, he will perceive the Confufion of the Picture, for the Reafons that have been jult alledged.

Therefore to prevent this in the Eye (Tab. XI. Fig. 2.) it was neceffary, that a fecond Refraction fhould be made, whereby the Rays might be collected at the Point $b$, inftead of the Point $k$.

That this may happen after the beft and moft ufeful Manner, the Cbryfalline Humour S T, muft be again Convex at SET, and that which follows at SGRHTES, thinner of Matter, and likewife tranfparent.

Now all thefe Particulars do occur here again; fince the Cbryftalline Humour (as you may obferve, if you take it out of the Eye) is not only Convex behind at $S E E T$, but much more fo than in the forepart of it SDDT; the whole Cavicy alfo of the Eye SGRHTES, behind the Cbrytalline Humour $S T$, is quite full of a very clear and bright Hu mour, about the Confiftence of melted Glafs, or, according to others, of the White of an Egg; at leaft, it is of a thinner Subftance (which is neceffary here) than the Cbryfalline Humour, and cherefore 'cis called the Vitreous Humour: This being fo, they that underftand the foregoing, mult likewife know that the Rays coming from $D E$, can't pafs directly thro' e to $k$, but being again broken at $E$, mult
be bent towards each other, and purfuing their way according to $E b, E b$, mult be united at $b$.

SECT. XIX. How the Image is formed in the Eye, and Convictions from the foregoing Obfervations.

Fifibly, Having thus fhewn, how the Rays, diverging from the Point $B$ of the Object $A B$, mult meer at the Bottom of the Eye in a Point $b$; if you fuppofe that thofe Rays which come from every other Point of $A B$, are likewife after the fame manner collected in a vifible Point of $a b$, you will alfo fee after what manner the above-mentioned Images are formed by the Light, upon the Bottom of the Eye, as it were in a dark Chamber.

Now can any Thing more be required by thofe who fincerely fearch after Truth, towards a Proof of the Wifdom of the Creator, than this wonderful Structure of the Eye, and thefe Inflections of the Rays repeated three times after one another; which, if they had been otherwife fcatter'd or feparated, would not only have been unfit in their own Nature, by reafon of fuch Divergency, to have formed an exact Image; but even produced a Motion which would have been directly oppofite to what the Sight required?

SECT. XX. Several Remarks; Firf, that the Eye is Black witbin.

W e might make innumerable Obfervations upon the wonderful Things that are to be found in the Eye; as, r. That the Eye muft be dark within, in order to reprefent the Images as ftrongly as is done in a dark Chamber, and is it not fo? Even fo far, that its Membranes or Tunicks, are in a great meafure, and for this very purpofe, of a Blackifh Colour: Can fo neceffary a Quality as this refult from Chance?

## S E C T. XXI. Tbe Second Remark; That the Chry falline

 Humour is a Microcoope: And Convicivins: frsin ibtace.2. To the end, that the Innges fhould be nice and accurate, ought there not to be in the Eye a tranfument Body, Convex on both fithe, and the mofl Gonvex-part undermoft? And do not bich thefe Qualities occar in the CbryfallineH:mour, which has the form of a polifhed Splecical Giafs before and behind, as likewife all its Properies?

For, if you take this Humour out of the Eye of a newly killed Beaft, and hoid it before a burging Candle, and a piece of white Paper behind ir, you will fee upon the Paper as exict an Image of the Fiame inverted, as if the fame were projected or made by a Gials: Or place the fame before your Eye, and the Head of a Pin, or any orher little Thing, clofe behind it, and if you look thro' it, you will fee che very fame 'Appearances as thro' a real Microfcope, which is likewife made Convex on both fides for the fame purpofe.

Did ever any one pretend to fay, that a good Microfcope had acquired irs Figure, its Tranfparency out of a dark. Matter, and its Difpofition of being fo ufeful, without any Defign of the Perfon that made it? How therefore can it be afferted of this Humour, where all thofe Qualities are found in a more eminent manner? Or could the beft Artificer in the World produce fuch a Thing from Bread, Flefh, Fifh, and other Food? Can then an unhappy Philofopher difcover neither Art nor Knowledge therein, after having obferved the like Appearances, not once only (which might have happen'd by chance) but in fo many Millions of Eyes, both of Men and Beafls?

SECT. XXII. The Tbird Remark, upon feeing at Several Diftances: An Experiment tbereupon.
3. ONe may yet farther fee by the Experiment in a dark Chamber, that the Diftance of the Object $A B$ (Tab. X. Fig. 3.) from the Paper $r$ s, and from the Glafs $S T$, ought to be certain and limited, to form a diftinct Image at $a b$ : So that the Paper being held at $p q$, nearer to the Glafs $S T$, or at $d e$, farther from the faid Glafs, if the Object $A B$, and the Glafs $S T$, remain in their place, the Image will be very confufed; becaufe the Rays coming from each of the Points $A$ and $B$, are not collected in the Point $a$ and $b$, but inftead thereof, fill a great face at $p$ and $g$, or $d$ and $e$; fo that thofe which proceed from different Points muft thereby be mix'd together and confufed.

From whence it appears, that no Images can be rightly and truly formed, when the Collection of the Rays that come from $A$ or $B$, are made at $a$ or $b$; the place of Collection $a b$, being either before the Paper, which is then at $d e$, or behind the $\mathrm{Pa}-$ per, when at $p q$.

Again, we likewife fee, if the Object $A B$ is farther from the Glafs $S T$, or the Glafs itfelf is rounder than at the time when a diftinct Image was formed thro' both of them at $a b$, the exact Image will fall clofer to the Glafs, as for inftance, at $p q$; and therefore the Paper muft, for this reafon, be brought forwards from $r$ s to $p q$, and near er to the Glals.

The contrary happens, if the Object $A B$, be brought clofer to the Glafs S T, or if the faid Glafs be not fo Convex, as we at firft fuppofed it; for then the exact Inage will not be found, unlefs the Paper be removed backwards to $d \mathrm{e}$, and the Diftance thereof from the Glafs rendered greater.

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Now, notwithftanding thatiall thefeThings come to pafs in our Eyes, yet would our Sight, for all this great Apparatus, be of little ufe, and wholly imperfect, with refpect to the Objects that are nean us: So that, for inftance, one who fees an Objeet diftinctly at the Diftance of a Yard, would not be able to diftinguifh the fame, either at the Diftance of half a Yard, or a Yard and half, or any otherwife, farther or nearer, unlefs the means abovemention'd were ufed in the Chamber of our Eye, viz. either by making the Roundnefs of one of the Humours more or lefs Convex, or the Diftance between the Cbryftalline Humour, and the Bottom of the Eye (which fupplies the place of the Paper) greater or fmaller, according as the nearnefs or remotenefs of the Object requires it.

If this fhould not be fufficiently intelligible to one that has not been verfed in Optical Experiments, let him in a dark Chamber make ufe of a flatter or more convex Glafs; or, to fpeak in the Language of the Glafs-Grinders, of younger or older Spectacles, and of a greater or fmaller Diftance of the Object; and Experience, after a little attention, will render the Thing plain enough to him.

Now, to apply all this to the purpofe; Can any one, without being aftonifh'd at the Wifdom and Goodnefs of his adorable Creator, obferve, that not only one of thefe means (which was enough alone) but both together are found in the Eyes? Eor when an Object is far from the Eye, and therefore (Tab. XI. Fig. 2.) the Point $a$ or $b$ (where the Rays proceeding from a Point $A$ or $B$ converge, or are gather'd together) does not reach the Bottom of the Eye $X m$, but falls nearer to the Cbryftalline Humour $S T$; a confufed Image, as has been faid before, would thereby be formed at the Bottom of the Eye, but no diftinct Vifion; fo, that to prevent the fame, it is neceflary that the Diftance betweer
the Bottom of the Eye $X m$, and the Cbryftalline Hu mour S T, Thould be frnaller ; or (if the Diftance becween them remain as it was) one of the $\mathrm{Hu}-$ mours of the Eye fhould be render'd lefs Convex, to caule the Image to fall farther, viz. at ab.

Now we find that to bring both thefe Things about together, the four Mufcles of the Eye, E F G H (Tab. X. Fig. s.) feem to be neceffary to move the fame (as any one of them is contracted, and fo made fhorter than the reft) upwards and downwards, and to the right and left; and when they act altogether they draw the fore-part of the Eye, as likewife the Cbryftalline Humour backwards, diminifhing in fuch manner the diftance between it and the Bottom of the Eye; but particularly, it is likewife plain, that they make the external Figure of the Eye, which is very Convex and Globular, much flatter, and fo caufe the collected Rays to fall more backward, in order to reach the Bottom of the Eye.

Now that the Rays coming from an Object, and falling upon a flatter Glafs, do paint the lmage further backwards than when the Glafs is more Convex, has been already fhewn in the Experiment of a dark Chamber.

Now if the Object (Tab. XI. Fig. 2.) be too near the Ese, and the Collection of the Rays coming from the Puinc $B$, does not happen upon $b$, but upon $k$, behind the Butrom of the Eye $X m$; it is plain enough, that to prevent it, the contrary mult be effected, namely, that the fpace between the Cbryftalline Humour, and the Bottom of the Eye $X m$, mould be greater; or (the face remaining the famt) the Agueous. Humour of the Eye at Mcc fomewhat rounder.

For that a rounder Glafs forms the Image fhorter and nearer to itfelf, may be experimentally proved with great eafe in a dark Chamber.

Now to perform both thefe Operations at the fame time, the Anatomifts produce two Mufcles at I N K M (Tab. X. Fig. 5.) which they call oblique Mufcles; and which, when contracted, do each of them draw the Eye on its fide, but when they work together, they draw the Eye as it were with a Girting Rope, and fwelling up, prefs it on all fides; by which means the Aqueous Humour being made protuberant, the Eye becomes rounder at NCC (Tab. XI. Fig. 2.) and the Vitreous Humour being preffed backwards, the Diftance between the Botrom of the Eye and the Cbryfalline Humour is render'd greater.

I know very well, that fome Learned Gentlemen do not think that the peculiar Ufe of there Mufcles, for this purpofe, is yet fully afcertained, till it has been further proved; but we fhall let ourfelves into this Difpute at prefent no more, than we fhall enquire whether thofe only have hit upon the Truth, who maintain, that the Fibres G S and HT (which the Anatomifts call Proceffus Ciliares) have a quality of caufing the Cbryftalline Humour itfelf (whenever it is neceffary) either to change its Figure, that is to fay, rendering it more or lefs Convex; or of bringing it nearer and removing it farther from the Bottom of the Eye.

However, the one or the other of the Operations above-mentioned, feems to be experimentally felt in the Uneafinefs, or fometimes even in the Pain, which the Eye fuffers, when we ufe any Force to fee an Object that is far from the Eye diftinctly, or to read a Writing a little too near.

But this is inconteffably true, that the Eye does fomething in the viewing of Things that are placed at feveral Diftances from it, without any Concurrence or Knowledge on our part, which the greateft Mathematicians have not yet been able to bring about by their Inftruments of feeing; the Difpofi- tion of which, as the diftance of an Object is renfibly greater or fmaller, muft likewife be alter'd. And this is fufficient to convince us (tho' we know nothing of the manner how it happens) that there is a Good, by whom we are made, and who had a wife End and Defign in forming the Eye, as it here appears.

S e c t. XXIII. The Fourth Remark, upon the Opening and Sbutting the Black of the Eye or Pupil, with an Experiment proving the fame.

Fourtbly, If this great and wonderful Structure of the Eye, by which we are enabled to fee fo eafily and diftinctly, at fo many and fuch different Diftances, be not yet fufficient to convince a Sceptical Enquirer of the Wifdom of his Creator ; let him proceed further, and in the laft place (fince, if we Pould take notice of every Thing concerning the Eye, this alone would require a whole Book) to contemplate with us that which follows:

Firft, That if the Hole in a dark Chamber be made fo fmall as to admit but too few of the Rays, the external Images would be reprefented imperfectly without the neceffary Force and Livelinefs.

Secondly, If the Hole be fo great as to admit of the Entrance of too much Light, the Images would appear yet more weak and imperfect for other Reafons. So that there is an exact Proportion required for that Hole or Space, thro' which the Rays are to pafs, to the end that every Thing may have its proper Energy; and that the number of the Rays be neicher too great nor too fmall: And how much trouble the finding the juft Proportion of fuch Holes or Openings occafions to thofe who make Telefcopes, Microfcopes, and other Inftruments for feeing, is but too well known by thofe that have had the trial of it.

The rame Thing happens to the Eye, as being: dark Cbamber; and it is eafie to difcover experimen tally, that too few Rays render the Sight of an Ob ject weak, if you make a Hole with a Pin in a whith. Paper, which Hole fhall be much fmaller than the little black Circle of the Eye, called in Latin, thi Pupilla; and thro' which the Rays of the Objecu are admitted into the Eye.

Now when you look thro' the faid little Holt (efpecially in a place where the Light is not toc ftrong) upon a piece of Marbled Paper, in which there are a great many Colours, it is well known: that if it be held clofe to the Eye, there can come no Rays from it but thro' the aforefaid little Hole: and that therefore the number of them is much fewer than if they were immediately received in a greater Opening of the Pupilla without this Hole : But we fhall likewife find at the fame time, that the Colours of the Marble Paper will fhew themfelves much fainter and darker thro' the litule Hole, than they would directly to the naked Eye.

Now in cafe this Pupil, being too large, fhould. admit too many Rays, as it does when one paffes fuddenly from a very dark Place into a clear and ftrong Light; we find likewife, that upon this account, the Action of Seeing becomes very troublefome.

Now to produce again a Proof of Go D's wonderful Wifdom and Mercy from this laft Inftance, Could any Body reafonably fuppofe, that what is done herein, with fo much trouble by the Artificers in their Optical Inftruments, is performed by the Eye of itfelf, and without the Direction of the great Creator, and even without the Knowledge of the Man himfelf in whom it happens? And moreover, after fuch a manner as infinitely exceeds the fineft Machine that Human Art has ever yet brought to the higheft degree of Perfection?

Thus we fee that the Paffage FF (Tab. XI. Fig. 2.) thro' which the Rays of Light go, or rather that black little Circle in the Membrane (according to which our Eyes are denominated Black, Grey, or any other Colour) commonly called, the Black or Apple of the Eye, becomes in a healchy Man fmaller in a great Light, and immediately greater in a fmall Light; in order to admit more or fewer Rays, as the Circumftances of Things require:

I know very well, that no Body who has never feen this will readily believe it; but in order to convince him thereof experimentally, let him be brought into the Sun-fhine, or any other ftrong Lighr, or place him in a Chamber directly oppofite to the Light of the Windows in a very bright Day; where, if you oblerve the Pupil of the Eye, you will find it to be very fmall in fuch a great Light, to the end, that the Eye may not be hurt by the ftrength thereof; then fet him in a dark Corner of a Chamber, and turn his Face from the Light; when you will prefently perceive the Pupil to become fenfibly larger, in order to admit a greater number of Rays; infomuch, that after thefe Experiments, no Body can doubt of what has been here laid.

Is not the great Goodnefs of God particularly remarkable herein, that all thefe Things come to pals in our Eye, without our being confcious thereof, to the end, that our Attention may not be diverted from whatever we are then contemplating? Which however would have always happen'd, if we had been obliged to have attended to every Occafion of adapting the Pupil to the Degrees of Light?

## SECT. XXIV. Convictions from the foregoing Ob-

 fervations.Now whofoever is a reafonable Perfon, and does plainly comprehend all that we have been faying about the Eye, ought he not to be aftonifh'd, that as there was a Lucretius among the Ancients, fo there are likewife in our Age, Men that pretend to be Philofophers and Enquirers after Truth, and yet will not allow that the Maker of all thefe Things, which contribute towards the forming of a good Sight, had any Wife Purpofes or Defigns in forming the fame?

And yer, if any of thefe Men fhould fee a good Microfope, or a Set of Magnifying-Glaffes, or a well-made Telefoope, or a dark Cbamber, with all its Apparatus, none of 'em will dare to fay, that thofe Things were framed by Chance. And can they then affirm it of the Eye, the Structure of which they muft own, whether they will or no, to be unfpeakably finer than all the Inftruments for Sight that ever were invented by the Art of Men?

Ask then the greateft Mathematician, the moft skilful Man in Optics, or Mechanics, whether he can be able to make a dark Chamber, that can be turned which way one will, as readily and eafily as the Eye; which, if turned towards remote Objects, can Morten itfelf and flatten its Glafs, and upon the nearer approach of an Object, can make itfelf longer and its Glafs rounder, without ftanding in need of any other Affiftance; yea (let the Caufe thereof be what it will) that can adapt itfelf to the various Diftances of Objects, and accordingly form at every time a different Object; that when the Light is too fmall, can dilate its Hole or Opening ; and when the Light is too ftrong, can again contract the fame, without the concurrence of any Thing

Thing elfe befides the Difpofition and Laws belonging to it?

Mult he not then acknowledge that this is not in his own Power? And in cafe he fhould fee fuch a Machine made by any Man, and compos'd only of fimple fluids, which for the moft part had their rife from Food, and yet fufficient to impart the Bleffings of Sight to all Animals, would he not own that fuch an Artificer was wonderfully skilful?

What fhall we then fay of a Man who, findingall this done afrer the moft glorious manner, fhall ftill perfift to deny the Wifdom of the Creator? Shall we count him Blind and Unhappy, or an obdurate Unbeliever?

Sect. XXV. The Sun neceflary to Sigbt: And Convictions from all the foregoing Obfervations.

Now, to fay no more, Have we no reafon to acknowledge the Goodnefs and Power of the Great Creator, who has made fuch unfpeakably great Bodies as the Sun is (not to mention the Moon and Stars) fubfervient to thefe Purpofes? Who, to compleat this Defign, and to make the Eye ufeful, has caufed the Light to flow from thence, in fo vaft a Quantity, as to be able to fill the immenfurable Space between us and the Firmament, even as far as to the Planet Saturn itfelf, which is fuppofed, and not without reafon, to be enlighten'd by the Sun; who derives the Light itfelf with fo unconceivable a Swiftnefs down to our Eyes, that they may be continually fupplied therewith, infomuch, that if fuch Swiftnefs, and all the other Properties of Light, of which we have been fpeaking (and of which we fhall treat hereafter more particularly) were not demonftrable, they might juftly be doubted of by every one.

Can any Body contemplate all thefe great Things, that are neceffary to make us fee, and that cooperate as well within as without the Eye, and nos think himfelf in the leaft obliged to Him that has beftowed fuch Bleffings on him? Who warns him thereby timely and from afar, of fo many Things, whether they be Advantageous or Prejudicial to him ; who grants him the Pleafure of being able to View and Contemplate fo many agreeable Colours in Fields, Trees, Flowers and the like; to fum up all in one Word, who has vouchfafed him the Faculty of Seeing; and who has made our Eye after a moft aftonifhing manner, a perfect Stage or Theatre, from whence we may view all his Wonders, how fmall foever it be in Comparifon of the Terreftrial and Celeftial Bodies; making of his Light an admirable Pencil, for fo the Mathematicians call the Compofition of Rays reprefented in Tab. X. Fig. 3. by $B S T b$; as alfo in Tab. XI. Fig. 2. by $B$, $C C, D D, E E, b$; which proceeding from a Point as $B$, are, after due Refractions, united again in another Point $b$, by which means all his great and glorious Works of Sun, Moon, Stars, Earth, Sea, Mountains, as alfo Trees, Flowers, Men, Beafts, and whatever elfe is corporeal and vifible, are painted after an inimitable manner, in their true Colours and Lineaments upon the Bottom of the Eye?

He that defires to fee a Refemblance of the fame, let him obferve that which happens in the fame manner in a dark Cbamber by the like Pencils or Rays of Light.

Now did ever any Body fee the Picture of a Man, or of any other Thing, well Drawn, and very Like, and which we ufually term, Drazun after the Life, and pretend to afcribe it to an accidental Concurrence of Colours? And yet will he dare to affirm the fame of the moft perfect Images

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of things that the Eye ever beheld? On the contray, Does it not appear from the formation of the noft artful and curious Theatre of the whole, great, corporeal Subftance in fuch a little Eye-bali, that among thofe noble Ends which our Dread Creator propos'd to himfelf, this is one of the chiefeft, :hat we fhould praife and honour him for the fame with a thankful Heart, and in the humbleft manmer adore his Power and Wifdom which he has thus wonderfully impreft on our Eyes, and chereby on our Minds ? Blind and Miferable are they, yea and much to be lamented, who obferving all thefe things, are not yet able to difcover their boundear Duty therein.

It is impoffible for us to quit this Subject before we be fatisfy'd that a wandering Philofopher has attain'd to another Notion of himfelf, and of the Greatnefs of his Creator. If there appear'd nothing more in the Univerfe than what is acknowledged to be True with refpect to the Sight, methinks no body can remain unconvinced of the adorable Perfections of his Maker. Let an unhappy Atheift retire by himfelf, and ferioully reflect whether he ever impartially confider'd the manner how Vifion is perform'd, if he has not yet done it, let him begin immediately, fince nothing elfe is neceffary in this cafe for conviction, but an earneft fcrutiny on his part; and if he finds himfelf ftill unfit, or averfe thereto, let him with bended Knees implore that God whom he does not yet acknowledge, but whom others that are allowed by him to be Wife and Learned, difcover fo plainly in all his Works, and efpecially in the formation of the Eye; I fay, let him addrefs himfelf to that God, in hopes that he who has fo wonderfully impreft the Piatures of his Creatures on his Eye, mighr alfo imprefs the Knowledge of his Attributes on his Mind, and that he who enlightens his Eyes, would likewife vouchfafe to enlighren his Underftanding.

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Can it ftill be thought to be the refult of met Chance (fince the Light, whilft it fcatters an fpreads its Rays afunder, is in itfelf improper t produce a clear and diftinct Sight) that neverthelef: and only to render Men and other Living Creature happy, Laws of Refraction were prefcribed to thit Light, by which its Rays were turned from Diven gent into Convergent, that is, from fcatter'd to uni red? Or that it is without Wifdom, that this grea and unfathomable Sea of Light, in all its moft mi nute Particles, has fubmitted to thefe Laws, with out departing one Tittle from them? Of which more hereafter.

Can any Body think it to be without a wiff Defign, that all the Limbs of a Human Creature from his Childhood to his Manhood, grow continually and proportionably greater, but the Cbry. falline Humour of the Eye only (forafmuch as out Sight depends upon the Figure thereof) does, without growing and increafing, always preferve the fame Size and Form both in Men and Children ? See this Remark in Bergerus, pag. 407.

If what has been faid before do not fully fatisfy him of the Wirdom of his Maker, but that however he begins to be ftagger'd by the Arguments that have been alledg'd, and to fufpect that his Notions may be groundlefs, efpecially fince he finds that the contrary Opinion is maintain'd by many whom he allows to be fagacious and free from Prejudices; let him think whether the inexpreffible greatnefs of fuch a Benefit as is the Sighr, fhould not ftir him up to Gratitude : let him alfo confider that if he were depriv'd of his Sight, with what confequence fuch a Lofs would be attended; it would be greater than we can conceive.

Particularly can any one exprefs the Confufion in which the whole World would be involv'd, if Mankind and all orher Animals were depriv'd of
heir Sight, and were ftark Blind? What could we therwife expect than that this Globe of the Earth would be quite difpeopled in the life of one Man, and perhaps much fooner, the Air depriv'd of all ts winged Creatures, the Seas and Rivers of all hat fwims and moves in them? Since in a very ittle time none would be able to fearch their Food or the fupport of their Lives, neither by themelves, nor by the help of any other. If now the jceptick finds any manner of probability in what has been faid, namely, that they who own a God, ind are thankful to him for fo inexpreffible a Beefir, are not altogether out of the way, muft not is natural Generofity, which fome of thefe Men eem fill to have retain'd, excite him to weigh it all very frequently, and with a ferious affiduity to xxamin things over and over; to the end that if he hould be miftaken in thofe Notions which he can rever prove, and which have no other foundation sut his own Fancy, he might not be guilty of a Vice fo deteftable to brave Souls, I mean, the higheft Ingratitude towards the greateft of all BenefaAtors? And ought he not therefore to be perfwaded of the abfolute neceffity he lies under, with the deepeft Humility to befeech that God, of whofe glorious Perfections and Works he yet fo much doubts, that he would in Mercy add to all his wonderful Works, this one more, namely, farther and fully to inform him of his Duty and Dependance? For at leaft he will be forced to admit it for a Truth, if thefe great Advantages which he enjoys by his Sight and Eyes, are only beftow'd upon him that he may teftify his Praife and Thankfulnefs to the great Giver; that the moft dreadful Punifhments, and greater Miferies than he ever faw to befall orher Men, do juftly hang over his Head, for having not only omitted thofe Duties, but likewife for treading under Foot, as far as he could, this Wife, Powerful

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Powerful and Gracious God. So that in cafe the foregoing Arguments do not induce him to Submiffion and Subjection to his Maker, perha the dread of his own Mifery will make him thir (fince he can not deny, that if there be a Wife an Righteous God, he will cercainly Punift a Difob dient and Blafphemous Creasure) that this Mattu is well worthy of Prayer and Inquiry, which at the only means whereby true Convition is to t hoped for.
If any one fhould object that we have dwelt to long upon there Reflections, we beg them to be lieve that we have no other view therein, than o perfwade atı unhappy Philofopher, if fuch a on fhould perufe thefe Papers, that he would feriouff confider the fame ; fince it feems ftill impoffible di me, that any body can comprehend it, and ye not own a God.

## CONTEMPLATION XIII.

 Of the Hearing.
## S EC T. I. The Inforuments of Hearing unknown.

NOW if we pafs from the Senfe of Seeing to that of Hearing, how Imall Progrefs has the Labour of Enquirers been able yet to make, in order to penetrate into the true manner how chis laft is perform'd, it will only be neceffary to quote the Expreffions of the famous Anatomift, Monfieur dus Verney, in the Preface of his moft laudable Treatife
about the Inftruments of Hearing : Among all the lnftruments wphich Animals ufe, thofe of the external Senfes are leaft of all known to us; but nevertbelefs, none of 'em all are attended with So much Ob curity as the Inftruments of Hearing. The fame is likewife acknowledged by Valfalva. It mult not therefore be expected, that we fhall fet the Wifdom of the adorable Creator in this Cafe, either in a full Light, or even demonftrate it fo plainly as has been done in the Bufinefs of Seeing ; this muft be the agreeable Employment of following Ages, when it thall pleafe the great Creator to give them a Clue to this Labyrinth, and further, to blefs their Enquiries, after repeated Difcoveries, concerning the Inftruments of Hearing, of Sound, and of Mujick.

S E C T. II. But they are fill Sufficient to prove the Wifdom of GOD.

However, to thew that notwithftanding Humane Wifdom is not yet capable of finding out the right Ufes of all thofe Inftruments that belong to the Senfe of Hearing; yet the Structure thereof, as far as it has hitherto been difcover'd, is fufficient to prove the wonderful Wifdom of the Creator to an Enquirer after Truth; and to convince an Atheift too, if he be not more Obftinate than Ignorant: Since we have not here undertaken to defcribe a compleat Anatomy of thefe Parts, it will not be ufelefs to transfer the following Figures from the Tables of Valfalva, which reprefent to the Life the Structure of the Inftruments that ferve for Hearing with refpect to each other; fo that from them, with fome others which we fhall add for greater Clearnefs, the Reader will be able to form a rough Conception thereof.

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## SECT. III. The External Structure of the Ear.

Let us then begin from the External Srructure of the Ear, which every one may fee in other Treatifes.

Can any one fuppofe that it is Accidental, and without Defign, that two Ears are placed upon the Head? which ferve to receive Sounds by the Mediation of the Air; as may be feen in feveral Beafts, who, as the Sound comes from certain Places, are wont to turn the Cavity of their Ears that way; as likewife in Men, who, when one of their Ears fail them, endeavour to repair that Defect, by holding the Hollow of their Hand behind it: And can one fee, without acknowledging a Defign of the Creator, that when the Sonoriferous Air is come into the Cavity of the External Part of the Ear, it meets with a moveable Protuberancy at the Mouth of the Auditory Tube (called by the Anatomifts the Fragus) by which the Air is hinder'd from avoiding this Entrance of the faid Tube, and compelled to run into its Orifice or Mouth?

Now forafmuch as the Ear, if it were compofed only of a Coft and flabby Matter, like the Membranes, would hang down over the Orifice of the Auditory Tube, and hinder Hearing; or if it were of a harder and bony Subftance, would occafion Inconveniencies in our lying down and otherwife : How manifeft is the Wifdom of the Creator, who has compofed the faid whole Ear of Membranes fupported with Cartilages? by which means it is endowed with an Elaftick Faculcy (as you may obferve when you bend the Ear with your Hand, and let it go again) to the end that it may redrefs itfelf, and return to its former State in all Accidents; and perhaps too, as fome think, to promote the Tremulous Motion of the Sonorous Air.


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This is certain, that the Auditory Tube is at the ,eginning of it , made of the fame Cartilaginous jubftance with the Ear, but farther in it, confifts of Bone only, as is fufficiently known to the Anaomifts.

SECT. IV. The Auditory Tube, and the Membrane called the Tympanum or Drum.

To fay fomething more of this, let (Tab. XI. Fig. 3.) $L L$ be the Circumference of the extreme part of the Ear, and $K$ the circular Cavity that appears thercin (called the Concba or Shell) and which oan be feen outwardly; and in which is alfo the O ifice of a Tube $A C$, which, extending it felf interraily in the Head, is called the Auditory Tube.

This confifting of a Cartilage about that Part of the Ear mark'd $A$, and afterwards as far as $C$, of a Bone only, is cloathed on the infide with a Skin or Membrane, which in this Figure is repre?ented alone wichout the Bone and Cartilage; and at the End of it F, it is Shut up by a Membrane which is ound, dry, thin, folid and cranfparent, and which is called the Drum of the Ear. But fome are of Opinion, that there is a fmall Orifice in this Membrane, which feems to be in fome meafure likely, becaufe fuch as take Tobacco have been obferved to convey the Smoak thereof from the Mouth thro' the Ears.

And thus we fee how the Sonoriferous Air, admitted into that Part of the Ear $L L$, and colleeted in the Carchas K, enters into the Auditory Tube, and pafing from $A$ to $C$, Atrikes againft the Membrane $F$, and puts it into Motion.

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SECT. V. The Cavity called tbe Drum, the Bones of the Ear, and the Chorảa or Little String.

Behind the Membrane of the Drum, more inwardly in the Head, there is a certain Cavity, which the Anatomifts call the Tympanum or Drum, upon which youl muit fuppofe that this Membrane is extended much after the fame manner as the Skin of a Kettle-Drum.

In this Cavity Anatomifts obferve feveral wonderful Things, fome of which are contained within it, and others in its Circumference: The firft things within it, are the four little Bones of the Ear, and a fmall Nerve, called the Cborda Tympani, or String of the Drum; to fay nothing here of the Mufcles, and other Singularities that occur therein. The other things confift mofly in the Openings that appear in the Bone of the Drum's Circumference, whereby the Cavity thereof has a Communication with other Cavities, either with, or without the intervention of Membranes.

The Auditory Bones (Tab. XI. Fig. 4.) are found to be four in number, $C S$ is the Hammer, B $P$ the Anvil, P V the Stirrup; and between the Anvil and Stirrup there lies at $P$, frnall roundifh Bone, which makes the fourth in Number.

Between two of thefe Bones (Tab. IX. Fig. 3.) there is a little Branch of a Nerve EO, or String of the Drum.

## SECT. VI. The Motion of tisofe Infruments.

Now if we fuppofe that the Tail $S$, of the Hammer C $S$, is faften'd to the Membrane of the Drum which lies there under it, we may obferve at the fame time, that this Membrane being moved by the Sound, which paffing into the Auditory Tube


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## Sect. V. the E،

Behin ${ }^{\text {] }}$ inwardly in which the $t$ upon which is extended of a KettleIn this C derful Thin: in it, and o things with Ear, and a! or Sering of Mufcles, an The other that appeal rence, whe nication wi out the inte The Aud: to be four i: Anvil, P V Stirrup ther makes the $f$ Between there is a li of the Drum SECT.

[^6]$A C$, Atrikes upon it, will likewife move the Hammer $C A$, as that will do the Anvil $B P$; by which lait, and by the fourth little Bone P (Tab. XI. Fig. 4.) the Sirruy $V P$, will likewife be moved: And fo the litic String or Nerve EO (Tab. XI. Fig. 3. when the Hammer $C S$, and the Anvil $B P$, are ftirred by th: Membrane of the Drum, will always follow the Motions thereof: So that from hence is appears, that the Motion of the Membe the of the Drum, communicates iifelf to all thefe littic Bunes, and to the Chorda Tympani.

SECT. VII. The Openings in the Circumference of the Cavity of the Drum.

To have a truc Notion of the Circumference of this Cavity, which an unskilful Perfon muft take care to diftinguifh from the Membrane of the Drum, fince Valfalua has not drawn it entirely, but only the Openings that are therein; you muft fuppofe it to be a Cavity that comes behind the Membrane of the Drum (Tab. XI. Fig. 3.) and encompaffes thefe litrle Bones: Or you may confult hereupon the Figures thereof in Monficur du Verney, which, if we fhould here reckon them up, would require too many Explanations.

In this Circumference then of the Cavity of the Drum Anatomifts do find;

1. The Opening of the inmoft part of the Auditory Tube $A C$ (Tab. XI. Fig. 3.) which is fhut up by the Drum Membrane $F$.
2. Ttie opening $H$, of the Tube HGI, called the Trumper of Euftacbius, which terminates at $I$, in the furchermoft Part of the Roof of the Mouth; fo that the Air paffing thro' it from the Mouth, from I to H , can enter into the Cavity of the Drum, and be again difcharged the fame way. The Wifdom of the Ceeator does wonderfully appear, in
making this Orifice in the Roof of the Mouth after fuch a manner, that the frefh Air drawn in by the Noftrils, is directed in its way thither by a little Protuberancy; and when it recurnis from the Lungs, charged with Vapours, it paffes by this Orifice more eafily than it can enter into it.

Valfalva fhews by Experience, that, this being ftopt, the Ear on the fame fide is immediately Deaf; but when open'd, hears again.

And this, according to all Appearances, is that Paffage for Sounds, by the help of which, Men that have been entirely Deaf, have fometimes been able to tune a Mufical Inftrument, and others have been found to hear by the Mouth; for which purpofe, a little Stick, held between the Teeth, or fet againft it with one End, has ofeentimes done great Service, whilft the ocher End, refting upon the Inftrument, ferves for a Paffage to the Tremulous Motion of the Air. The Paffage of the Tobacco Smoak from the Mouth to the Ear, of which we have already fooken, may perhaps be traced after the fame manner.
3. The little Part of the Bone $D$, is the fide of a Bay or Creek, which makes the Cavity of the Drum larger, and is concinued to the Cavity of another Bone, called the Apopby/s Mammillaris, or Maftoides. In the firft Entrance of this Bay, the fharp End of the Anvil refts, as may be feen at $D$.
4. In the upper Part of this Bay, Valjalua has difcover'd Several Holes, by which there is a Communication between the Cavity of the Drum and that of the Skull itfelf.
5. There are yet two Openings in the Circumference of the Drum; the firft of 'em are called the OvalWindows (Tab. XI. Fig. 5) o, and this Opening is ftop by the Sirrup
6. The cther is called the Round Windown $p$; which is fhut by a Membane like that of the Drum. You nult fuppofe, that both there Openings, $o$ and $p$, ire here in one Bone, which is a part of the Cirzumference of the Drum's Cavity; and that all heíe Threads and little Tubes 1,2,3,4, are quite jut of the Drum's Cavity, which we have put out of the way, that they mayn't hinder the Sight of hem.

## Sect. VIII. The Labyrinth or Maze of the Ear.

These two Oval and Round Windows open the way for Enquirers to the laft and moft inward Cavity of the Ear, which, by reafon of its wonderful Figure, is call'd the Labyrinth. Being ftrip'd of the Bones that lie about it, it Thews itfelf as defrribed in the Table, only the End or Point of this Snail's Courfe 4, muft be thewn fomewhat rifing from the Paper, and not lying in the fame plane with all its Windings, juft as you fee in the Snails themfelves, their Point a little elevated. I add this Remark, becaufe mention'd by Valfalua. You may fee it better delineated in Tab. XII. Fig. I. but with the fame Faule as Tab. XI. Fig. 6. and the better to fhew all the Parts, the Labyrinths are placed in a different Situation.

The Parss of this laft Cavity (the Labyrinth) are commonly divided into three; namely, Firft, three Semi-circular Veffels, $1,2,3$. Secondly, the Cochlea or Snail 4 ; and Thirdly, a Cavity calleth the Vefibulum or Porch, which lies between the two, and which, for the greater clearnefs, is reprefented open, (Tab. XI. Fig. 6.) To fay a Word or two of each.

We fee that thefe Semi-circular Veffels, 1, 2, 3, have an Opening at each End into the Veftibulum; but that two of 'em 1 and 2, are unied in one Veffel at 5 and 6: And therefore, that there are not fix but five Orifices in the whole: Moreover,
we fee on the fide oppofite to the Porch the Cocb. lea 4, this is divided according to its Length and Bending into two particular Tubes by a kind of a Septum or Partition-Membrane; which likewife. according to its Length, confifts of two differeni Sorts of Matrers: the one is membranous, which Valfalva (fee his Tab. VIII. Fig. 7.) thinks is probably formed from a Branch e, of the Soft Auditory Nerve fpread out into a Membrane (Tab. XI. Fig. 7.) And the other kind of Matter is dry, thin and rough, according to Du Verney, and between the folidicy of a Cartilage and a Membrane, as Valfalva fays of it. This at leaft feems to be true, that chis Matter renders the Septum very fir for propagating the Tremulous Motion of the Sound.

Of the two Tubes which are made in the Cocblea 4, one is fhut up in a Membrane; and the round Window $p$, of which mention is made above (Tab. XI. Fig. 5.) in the Opening itfelf: So that between this Iube, or rather berween the half Cavity of the Cocblea and the Drum's Cavity, nothing but this Membrane does appear.

Tab. XI. Fig. G. $r$ is likewife the Orifice of ancther Tube, which is open at the Vefibulum.

The Anatomifts name both thefe Tubes, into which the Cavity of the Cocblea 4 is divided, the Scale or Stairs.

Laftly, we find that the Veftibulum (befides the five Openings of the Semi-circular Veffels, one of the Cocbler, and ftill five others thro' which the Auditory Nerves pafs, and by which thefe Openings are ftopr) has yet one more reprefented (Tab. XI. Fis. 5.) by o, and Fig. 6. by $q$; viz. the afore-mention'd Oval Window, which is ftopt by the little Bone of the Ear called the Stirrup; yet in fuch a manner, that the Membrane which is between that Bone and the Edge of this oval Opening or Wino dow, gives a Liberty to the Stirrup to be moved upwards and downwards:

## Sect. IX. The Auditory Nerves.

BEFORE we go any farther, we muft fay fomething of the Auditory Nerves, the Soft Parts whereof $c d$ (Tab. XI. Fig. 7.) being divided into five Branches, pals thro' the aforefaid Openings into the Vefibulum, where, being expanded, they compofe the Membrane of this Veftibulum; and from this Membrane likewife, there proceed five others, which entering into the Semi-circular Velfels, and coming with each other from both fides, are united in one Membrane. You may fee them in this Figure, which appears fufficiently in Fig. 6. if inftead of the Tubes you fuppofe you fee the Membranes which are there, and which are made of the expanded Auditory Nerves.

So likewife, according to Valfalva, the little Branch of the Nerve e in the Cocblea, produces the Membrane $g$, which, as we faid before, makes one fide of the Septum, that divides the whole Cocblea into two Tubes.

SECT. X. All the Inftruments of Hearing Shervn.
After all thefe Particulars, we Thall proceed to reprefent the entire Structure of the Inftruments of Hearing jointly with one another, and at the fame time, give you a brief Account of the Opinions of the Principal Anatomifts concerning their refpective Ufes: You may fee them in Tab. XII. Fig. i. which, to range them in order as they appear, did not coft a littie trouble to Valfalva, as he himfelf fays of it.

Here then we find the Ear reprefented, not as it is feen before, or as it is extended towards the Face; but inflected a little towards the hinder Part of the Head, to fhew all the orher Matters more plainly.
$A A$ is the Ear, in which the Sound is inclofed; and $B$ the Cocblea, or Shell, in which the Sonorous Air is collected, which, paffing from thence into the Auditory Tube C C, ftrikes upon the Membrane of the Drum ego, and thereby communicates at Tremulous Motion to the faid Membrane.

## Sect. XI. An Experiment feewing that the Auditory Tube increajes the Sound.

I r muft not be thought that this is faid without any ground, fince it is very probable, that the Air, paffing thro' the Cocblea B, and the Auditory Tube C C (which together make a natural Speaking Horn or Trumpet) ftrikes much more ftrongly upon the Drum-Membrane that fhuts the faid Tube, than if it ftruck againft the faid Membrane, without paffing thro' this Tube.

This is plain in fuch as are Deaf, and who are obliged fometimes to put into their Ear, either a crooked or ftrait Tube, the Mouth of which is large, and the lower part narrower, in order to hear the better.

And if a Man that is not deaf has a mind to make the Tryal, let him take one of thofe fpeaking Trumpers that were invented in the laft Century (fee Tab. XII. Fig. 2.) A E, and fet the narrow Part of it againft his Ear, and let fome Body whiPper foftly at the wide Part E; and he fhall find, tho' the Tube be about Six Foot long, as mine is, that he will hear the Speaker very plainly and difinctly, even at the time when other Perfons, ftanding much nearer to the Mouch of him that Speaks, and lift'ning with all the Attention they can, will not be able, by reafon of the lownefs of his Voice, to hear or underftand any Thing he fays.

After the fame manner we likewife perceive, that the Sound produced by blowing thro' a Trumpet or Horn, is heard incompdrably louder than that which any Man can make with his Mouth only.

Sect. XII. Sounds produce a Tremulous Motion in the Drum-Membrane, Shewn Experimentally.

Now to fhew farther, that the Air acting more ftrongly upon the Drum-Membrane cg 0 , thro' this natural Auditory Tube $A A B C C$ (Tab. XII. Fig. r.) produces therein a fhivering or tremulcus Motion, one might firft inftance in the manner that all refounding Bodies are moved, which, vibrating fwiffly backwards and forwards, ftrike againft the Circumambient Particles of Air, and fo communicate this tremulous Motion. One may perceive this fame tremulous Motion very fenfibly in Bells, in the Strings of Mufical Inftruments and other Things, by laying one's Finger or any other Matter upon them when they are made to found; and very plainly in the known Experiment of a Drinking-Glafs with a little Water in it, by wetting the Finger and preffing it round the Brim; and at the fame time that it yields a Sound, if you place the other Hand at the Foot or Bottom of the Glafs, you may feel the faid tremulous Motion.

And to fee, by way of Comparifon, how the Air is moved by fuch a refounding Glafs, you need only pour as much more Water in ir, which will fill it almoft to the Brim, when prefling the faid Brim round again with the Finger, you will vifibly difcover in the Water, the tremulous Motion occafion'd by the Glafs; juft fo is the Air likewife moved.

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Sect. XIII. Other Experiments proving the fame Thing.

Bu $\frac{1}{}$ not to difcourfe too long nor too deeply about the Nature of Sounds, which are not yet fully known to us, this is fufficiently certain, that after what manner foever the Air be put into Miotion, in order to produce Sounds, it is capable of saufing the Bodies againft which it ftrikes to tremble.

Now, to fay nothing here of thofe Motions which the Sound of a Cannon produces in the Air, and by which it caufes Doors and Glaffes, with many other folid Bodies, not only to tremble, but so burft in pieces; this is very plain, that if you Arike wich your Finger upon the Thread or String of a Mufical Inftrument, for inftance, a Violin; the other Hand, in which you hold the faid Infrrument, will in fome meafure feel the Wood to tremble.

But now to fhew the Analogy thereof with the Ear, about which we have been treating; take away the Mouth-Piece of a Speaking-Trumper, A, B, C (Tab. XII. Fig. 2.) and inftead thereof, let a dry thin Hog's Bladder be fpread over the Orifice as fmooth and tight as may be; or in cafe the Rim or Edge of the faid Trumpet $B C$, be armed with a kind of Teeth, as fome are for Ornamentfake, and that there be danger from thence of burfting the Bladder in the Expanfion thereof, you may put a four-double Paper, with a great round Hole in the middle, upon thofe Teeth, before you fpread the Biadder over them ; this being done, let the Trumper, with its largeft Orifice $D F$, be placed upon the fide of two Chairs, fo that it may ftand ftrcight up, and the Bladder be on the Top at BC.

Now in cafe you thould lay three or four little Feathers of a Quill upon the faid Bladder, and caufe a Man lying upon his Back upon the Floor, with his Head berween the two Chairs, and his Mouth directly under the middle of the Tube $E$, to call or fpeak out aloud, you fhall perceive, that the Sound ftriking upon the Bladder, will produce a tremulous Motion in the fame, and in the little Feathers lying upon it; which Motion, or Trembling, may be likewife felt, if you hold the Tube in your Hand, and lay your Finger upon the Bladder at $B C$, when any Body fpeaks whofe Mouth is placed at $E$.

Thus then we fee (taking the Speaking-Trumpet for the Auditory Tube $A A B C C$ (Tab. XII. Fig. I.) and the Bladder for the Drum-Miembrane, which is expanded over the Auditory Tube at $\operatorname{cg} 0 \mathrm{O}$; that the faid Membrane muft be affected with a tremulous Motion, by the Sound entering the Ear, as alfo the Hammer $n$, whofe Stalk or Handle is faften'd to the Drum-Membrane.

## Sect. XIV. The Tremulous Motion of the Auditory

 Bones.Now by this Hammer muft the little Nerve $c 7$ (which fhews itfelf here between the Hammer $n$ and the Anvil $m$ ) be likewife moved; of which we fhall fay fomething more hereafter. But it is particularly plain that the Hammer $n$, being moved by the tremulous Motion of the Drum-Membrane, derives the fame Motion to the Anvil $m$, and by that to she Stirrup p.

The Stirrup p, which does here clofe the Oval Orifice in the Porch 4, both by itfelf and the Membrane that furrounds it (this Orifice does not appear very plain here, but you may fee it in (Tab. XI. Fig: 5. at 0 , and Fig. 6. at g) being thus put inio a tremulous Motion, both by the Sound and by the
the trembling of the Drum-Membrane, and the reft of the Auditory Bones; we likewife fee that the Air in the Porch 4, and moreover in the Semicircular Veffels $1,2,3$, and in the one Tube, or half of the Cochlea 5 , will be mored; and alfo through the round Orifice p, (Tab. XI. Fig. 5.) the Air in the other Tube, and like the former (Tab. XII. Fig. r.) by the Auditory, Bones, or by the Hammer $n_{0}$ the Anvil $m$, and the Stirrup $p$; but by the motion of the Air in the Cavity of the Drum, which is to be found between the Drum-Membrane and this round Orifice; which Air being, moved by the Drum-Membrane, and likewife by that Membrane that clofes the round Orifice $p$ (Tab. XI. Fig. s.) and the Air Tab. XII. Fig. 1.) that is behind in the other half Tube of the Cocblea 5 , will be moved. This is the Opinion of Monfieur du Verney, about the round Window, from whom Valjalva, does herein fomewhat differ: They that pleafe may confult "em both, or flay till the uncercainty of the Ufe of this round Orifice be removed by future Experiments. But to proceed:

Sect. XX. The like Motion in the Membrane of the Labyrinth.

This Air being put now into Motion throughout the whole Labyrinth $\mathrm{r}, 2,3,4,5$, (Tab. Xil. Fig. 1.) the Membranes (that are therein, and are reprefented by Fig. 7. Tab. XI.) or rather the Auditory Nerve 6, mutt needs be moved thereby; which Nerve encers this Labyrinth thro' five Orifices 'Tab. XII. Fig. 1.) three of which are feen on this fide the Porch like fo many Points; and being there, and Spreading out its Branches into Membranes (when they are moved by the Air) as well in the Porch as in the three Semi-circular Veffels, and the Cocblea, the Sunfe of Hearing is thereby produced.

So that finally thefe Nervous Mentbrapes in all the Cavities and Tubes of the Labyrinth 1, 2, 3, 4, 5, feem to be the Inftruments by which, and the Labyrinth itfelf the Place where, the Hearing is formed, becaufe the motion of the Sound does there affect the Auditory Nerves, or the Membranes produced by the Expanfion of the fame.

Now that this is not advanced by many, without good Grounds, feems to be in fome manner proved by an Obfervation which Valfalua made upon the Body of a Deaf Perfon. Cb. II. §. 10. where the Meinbrane that encompaffes the Stirrup, and Shuts the Oval Orifice, was found to be all Bone, and for that reafon the Stirrup was immoveable, which, according to him, was the Caufe of that Deafnefs; to which we may add, that the DrumMembrane being broken, the Hearing does not immediately fail, but only afcer a good while, when the other lnftruments of Heating, lying too naked and expofed to the Air, are perhaps corrupted. So that properly the Drum-Membrane does not feem to be the immediate Inftrument of Hearing.

## S ect. XVI. Convictions from fome Particulars.

I now leave it to the Judgment of an Atheift himfelf, how many things relating to the Ules of thefe Inftruments of Hearing may be fill concealed from us; or, whether fo many as are hitherto known to us, are formed and fixed in the Place where we find them by mere Chance, or without a wife Defign?

Dares he now afcribe the Figure of thofe little Trumpets or Horns that Deaf People make ufe of, to Chance, or ignorant Caufes? Can he then with the leaft Appearance of Realon, advance fuch Notions of this which is found in the Ears of all

Men $L$, and is reprefented in Tab. XI. Fig. 3. by the Concba $K$, and the Auditory Tube $A B C$.

Efpecially knowing, as he does, the Inconveniencies which any little Things or Infects produce, when they get into that Tube; and feeing befides, that that Veffel is encompaffed wi h a number of fmall Glands at $A$, which have likewife Nieir own little Veffels, from whence a tough and yellow Matter is continually filtrated; the Ufe whereof is not only to preferve the Tube in a proper State of moifture, fo that it may not be too much dry'd by the Air, nor yet renderd too foft and flabby if the faid Matter were thinner; but chiefly to ftop the way to the innermoft Part of the Ear, and Barricade it againft Flies and other little Animals by the aforefaid tough Matter, and alfo by the little Hairs that grow therein; and in cafe any of thofe Creatures fhould have infinuated themfelves too far, the bitterifh Taft of that Matter will deterr them from advancing any further.

The Wonders of this Structure of the Ear, fo far as they relate to the little Mufcles placed therein, may be feen in the Books of thofe who have learnedly treated of the fame, fuch as Valfalva, Du Verney and others: $d$ is one of thofe Mufcles reprefented in Tab. XII. Fig. i. as feparated from the Bone-Tube in which it is placed; which alfo ferves to draw the Hammer, and thereby more or lefs to expand the Drum-Membrane, and, together with the other Mufcle $f f$, to open at the proper time the Tube $H I$, which runs from the Cavity of the Drum, to the hindmoft Part of the Roof: At $g$ we fee a fmall Mufcle, which is inferted in the Head of the Stirrup, and which can ftretch more or lefs the little Membrane that fhuts the Oval Orifice, in order to render it more Serviceable to the mostion of the Sound. But this we fhall pafs by. of Hearing in Toung and Grown Pcople.

N ow if the Wifdom of the Creator does not palpably appear from all the aforegoing, let any reafonable Body judge, when he fees, that in Tab. XII. Fig. I. the little bones of Hearing $n, m, p$, and thofe that compofe the Labyrinth $1,2,3,4,5$, are of the very fame Size in a little Child as in a grown Man ; whereas all other Bones do moftly grow with the Body; the reafon of which, as it fhould feem, is, that in cafe the Inftruments of Hearing fhould alter, the Voice of the Children themfelves, of their Parents, and other Sounds, already known to Children, might, by the growth of thefe Inftruments, become ftrange and uncouth to them, and fo occafion Miftakes and Confufion.

And to be convinced, that this happens with Defign, and merely by the Wifdom of the Creator, we need only take notice, that where it is neceffary that all thefe things fhould remain in the fame jate in a Child and in a frown Perfon, the fame loes accordingly happen; but when any Alteration s neceffary, that alfo happens: Accordingly in a rrown Perfon it is neceffary that the Auditory Tube 3CC, fhould be wholly open to the Drum-Memrane $c, g, 0, c$, and the Membrane of the Drum it elf dry, and not too flabby; But if this Thould hap,en in the fame manner in Children, that Moifture, vith which they are encompaffed before their Birth, would render the Druin-Membrane too foft nd flaboy to be of ufe-to them afterwards: From vherice it is, as Anatomifts oblerve, that the Aulicory Tube in new-born Children, is narrower, nd fope by another kind of Matter, infomuch, hat the Humidity of the Matrix cannot approach : ; which ftopping Matter is found to difappear of
itfelf in a few Days after the Birth, to accuftom the Children by degrees to the Impreffion of the Air upon the Drum-Membrane, and fo to the Senfe of Hearing, of which they are deprived even after Birth, fo long as this Obftruction lafts in the Auditory Tube.

## Sect. XVIII. Convictions from wwhat bas been faid.

Now let an unhappy Atheift ask himfelf whether this can be afcrib'd to Neceffary and Ignorant Caufes (as for Cbance, I believe no body will pretend it) that whereas the Senfe of Hearing requires proper Inftruments both in Young and Old, the faid Inftruments are of the fame Magnitude and Form in both; and that wherever it was neceffary that there fhould be a Difference, we find not only fuch a Difference, but even fuch a one as is beft adapted to the refpective Ages of grown Men, and of Children?

Yea to one that has not loft the ufe of his Reafon, this alone feems to evince the Goodnefs and Wifdom of our Creator, infomuch that to difcover the adorable Traces and Footfteps of a Divine $\mathrm{Be}-$ ing, the moft obftinate Atheift need only ferioully to contemplate the firft Figure in Tab. XII. and confider at the fame time, that this is the wonderful Structure, which like the Work of a Statuary, is as it were hew'd out of the hardeft Bone in all Men, and beftows on all Creatures the Happinefs of Hearing.

The only Evafion therefore to which fuch a miferable Philofopher can betake himfelf, is: that the Ufes whereto all thefe Parts are peculiarly adapted, be not yet entirely manifefted to Inquirers; which makes them ftill hope that a dreadful God, whom they have fo frequently Blafphem'd, is nor to be difcover'd in the Texture of the Audicory

Tubes and Inftruments: as if every Thing that is not perfectly underftood by them, muft be immediately impured to Fortuitous Productions.

In anfwer to which we beg him to confider with himfelf, whether all rational Perfons will not condemin chis Method of drawing fuch an Abfurd Conclufion from his own Ignorance only ; and rell him that, far from making his own weak Conceptions the: ground of his Inference, that thofe Things are form'd without Wifdom ; the great Advantages refulting from the Thing itfelf, muft needs induce him to conclude thereupon, that the Maker of it was not only Wife, but in a much higher degree more Wife than he who paifes this Judgment on fuch a wonderful Machine ; and that it would be much more commendable in him earneftly to endeavnur to underftand it all, and to examin into this Wifdom, which, tho' yet conceal'd from him, ought neverthelefs to be the Object of his Adoration.

Can he fhow us plainly and clearly how Sounds are produced in Trumpets, Haut-bois, and other WindMufick? Can he account for the Motions and Modulations of the Air inclos'd in them? Are not innumerable Circumftances relating to the Inftruments of Sound, to the variations of Tomes, and what elfe belongs to the fame, ftill a Secret to him, and the greateft Philofophers? And yer would he prefume to afcribe their Structure, when he obferves their Ufes, to Chance or Ignorant Caufes, and conclude that it was to thefe they ow'd their Original?

When therefore he contemplates the Inftruments of Hearing fo neceffary to all Men living, and the great number of them, let him, in order to come to a founder Mind, ask himfelf, whether if he could with any fhew of Reafon fuppofe a Man, from whom he had nothing to fear, to be the Inventer thereof, he could nor, with much lefs Scruple of Vol. I.

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Confcience, impute the Wifdom of fuch an Invention, to fuch a Mant, than to Fortuitous and Ignorant Caufes: and therefore whether it be not the Fear of being forced to own an Adorable and Powerful Creator which reftrains him, rather than the true Evidence of his own Mind; how much foever he pretends, that nothing elfe induces him to deny all the Wifdom and Contrivance in thefe Things.

I fay once again, let our unhappy Philofopher inquire ftrictly into thefe Things, forafmuch as not only his Eternal Happinefs (which perhaps is a Jeft to him) but all his Content Pleafure and Eafe even in this Life do entirely depend upon it; for the Matter being f , that it is rather out of fear of meeting a great, and, to his Enemies, a Terrible God herein, than from the Conviction of his Judgment, that he refufes to acknowledge his Dread Creator, and yet continues to Blafpheme him and his glorious Attributes, how can he at all be releafed from fuch Fear? How can he ever attain any certain Tranquility in this Life? When from the Thoufands of Objects, even from every Thing that he Hears, Sees, Smells, Tafts and Feels, he is continually put to feek for Arguments to quiet his Mind againft the Wifdom, Power and Goodnefs of the great Creator, which Thine forth fo clearly in all of them : and in each of which, if he does but difcover any Thing of thofe Attributes, as obfcure and dark as they may appear to him, he will find new, and perpetual Occafions of Terror. And fince he can no other way defend his Notions, but by pretending that he is ftill diffatisfy'd in a Bufinefs, of which fo many wife Men own themfelves fully convinced, and of the Happinefs refulting from fuch Conviction, will he not feel (in contemplating the fmalleft Creature in this his uncertaincy, whether thofe who own and ferve a God
are in the right) that continual Doubtings in fpite of all his endeavours will arife in his Mind, and threaten him, in cafe his Notions are wrong, with utter Ruin from the Difpleafure of his Maker ?

Let an Atheift think with himfelf whether all this be not true, and how Deplorable then his Condition muft be. And whether our Creator himfelf does not juftly make ufe of the Ear to convince fuch as he in the 94 P alm, v. 8, and 9 . Underftand ye Brutifh among the People; and ye Fools when will ye be Wife? He that Planted the Ear, hall be not Hear? He tbat formed the Eye, fall be not fee? I beg him therefore to reflect in good earneft upon thefe Things.

## SECT. XIX. What is meant by Sound.

Now whether or no the Spirit of God has thought fit to hint at the chief Properties of Hearing, fince Natural Philofophy has not yet clear'd up the fame: this is plain that the Properties which are beft known to us at this time, feem to be difcoverable in his Holy Word.

To give a few Inftances thereof: It is obvious that all we Hear is only a kind of Sound; this has been confider'd as a Quality inherent in the Body, by all the Antient lnquirers into Nature, but a more ftrict and diftinct Scrutiny has convinced later Ages, that by Sound a twofold Thing is commonly underftood.

Firft, A Motion in the Bodies from whence Sound arifes, which again produces a tremulous Motion in the Air, as that again moves the Inftruments of Hearing, by the Tympanum, againft which it firft ftrikes. And this Kind, which confifts only in fuch a Motion, is called by the Learned, Sonus Primus. Vid. Bobnius and Bergerus in their Treatifes about Sounds.

Secondly, By the Word Sound is likewife meant, that Senfation produced in us by fuch a Motion; fo that we mult not imagin that what we Hear is in the Bodies or Air that furround us, in which we perceive nothing but a certain Sort of Motion; juft as in the Senfations produced in our Body by the Prick of a Pin, concerning which we muft not fanfy that the Pain we feel is without us, either in the Pin itfelf, or in other Bodits: but that what we name the fenfible or Audible Sound, does indeed begin in our Ears by fuch Motion of the Air, but does not acquire the true Properties of Sound till it be perceiv'd by the Soul, which is afrer an unconceivable manner united to the Body. And is what we call Sonus Secundus.

So that, not to concern ourfelves here, how the Soul is affected, there is one Sound which is form'd, and has irs exiftence in external Bodies; and another Sound in the Ear, and particularly in the Labyrinth, by the Membranes that compofe the extended Auditory Nerve; but properly in the Soul, by the Paffions and Senfations which are excired therein.

Now if any one thould infift, as it is the Hypothefis of fome Philofophers, that all this belongs to one and the fame Sownd, it is but only changing the Names, and there will be no Harm in it; it is no lefs crue however, that, notwithftanding all thefe Things muft concur to produce a Sound perfect in all its Circumftances, the Name of Sound is given by the Nodern Philofophers to both; by which means many Properties thereof are defcrib'd with eafe and brevity.

S E C T. XX. The Inftruments of Hearing are unneceefary wishout Air. And Convictions from thence.

Now, as the Eye without Light, fo this wonderful Structure of the Inftruments of Hearing, would be in a manner ufelefs, if he, that takes fuch great Care of all his Creatures, had not vouchfafed to encompafs that Globe upon which they live with a vaft Ocean of Air. Does not this then adminifter an occafion to us alfo, to praife the Goodnefs and. Wifdom of the Creator, who has been pleafed fo to adjuft thefe Inftruments of Hearing, that whilft Men live and breath in the Air, they are exactly adapted to difcover to us, after fuch a wonderful Manner, the Motion thereof, by means of an Impreffion which the Sound produces in us; and which is only applicable to this Senfe of Hearing?

Will any one dare to maintain, if he faw a Ship failing with all its Tackle, that the Ropes, Sails, Pullies, and whatfoever elfe is neceffary to adapt it to the Wind, are put into fuch a State by mere Chance, or without Defign ; and yet that every one of them was very ufeful in caufing the Ship to move? And is it not more unreafonable to affert the fame of thefe wonderful Things, which, as to the manner of their Operation, have hitherto been infcrutable? For thefe are not governed by a ftrong and fenfible Motion of the Air, fuch as the Wind is, but are adapted by a much more fecret and infenfible Motion thereof, with the Affiftance of feveral Mufcles, which dilate or contract thefe Inftruments of Hearing: And yet it muft be confers'd, that the Ules and Advantages of fuch a Motion are much greater than that produced by the Wind in a Ship, in which latter a very few may be concerned, bur the former affects all living Creatures; and
the Benefit thereof is communicated to them after the moft convenient manner, and even without any Concurrence or Trouble on their Part.

## SECT. XXI. The Nerves that are moved in Hearing.

To proceed now to thofe other Matters of which we promifed to fay fomething in the following Difcourfe: We have fhewn before, in Tab. XI. Fig. 3. a fmall Nervous Body EO (which in Tab. XII. Fig. r. is reprefented by c 7) This is obferved to run acrofs the Drum-Membrane, between the two Auditory Bones, viz. the Hammer C S, and the Anvil $B P$; and forafmuch as the Hammer CS is faften'd to the faid Drum-Membrane, tis plain enough, that that Membrane being moved by Sounds, fuch Motion muft neceffarily be continued to the Hammer, and to the faid Nervous Cord or String E O: So that in every Motion of the DrumMembrane, that is, as often as one hears any thing, this little Nerve EO, is put into a tremulous Motion.

Se c r. XXII. The UTe of the faid Nervou Cord.
Concerning the right Ufe of this little Nerve the Opinions of the Anatomifts are various, all of 'em looking upon it as a thing fufficiently obfcure. It is called by the Antients Cborda Tympani, or the String of the Drun, and efteemed to be of the fame Ufe as the Strings of the Soldiers Drums.

Mr. Maurice Hoffman in his Idea Macbina, p. 232. has collected the feveral Notions of the Learned about this Nervous String. Fallopius, fays he, was uncertain what it was; Euftacbius takes it for a Branch of the Neryes of the Fourth Pair; notwithftand-
ing which Mr. Gafper Hoffman acknowledges ingenuoufly, that he did nor know what fort of a Body this was, nor to what End, nor where it was inferted; and thought it might be an uncertain Work of fporting Nature, and that a great many were miftaken concerning it. Whereupon Riolanus having fince anfwer'd him, fays, that it is a nervous Fibre derived from the Auditory Nerve. Finally, Monfieur $d u$ Verney has irrefragably proved, that this nervous Cord is a Branch of the Fifth Pair, which proceeding forwards, joins itfelf to the hard Auditory Nerve.

The faid Monfieur Du Verney lays down the Ufe thereof in his Treatife de Organ. Audit. p. 12, 13. faying, that it communicates Branches to the little Mufcles of the Auditory Bones, and what elfe there may be in the Cavity of the Drum, in order to produce Motion.

Monfieur M. Hoffiman fuppofes, that it ferves to communicate Morion and Senfation to the DrumMembrane, at leaft to give it its proper 'Tenfion.

Touching this String, the Reader may confult Valfalva, who having written later than the abovemention'd Gentleman, has declared his Opinion with fome Warmth in his Accurate Defcription of the Ear, Cap. II. ©.22. Thefe are his Words as they ftand there; Moreover that this nervous Branch runs fo naked and undicover'd, So fimple and alone, So regularly and So conftantly tbro' the Cavity of the Drum, and particularly that it lyes fo between the Auditory Bones, that it is immediately put into Motion as Joons as ever the Said Bones are moved; all tbefe Tbings berv, that tbere is fome great Myfery of Nature concealed in this Branch, and bave therefore induced me frequently to conicmplate the fame both with my Eyes and my Mind, being defirous to find out Somerbing perbaps new in the Diffection, or at leaft the Caufes thereof. After which he rells us what his Thoughts were concerning it, and what he had be-
gun to difcover therein, and fo concludes with thefe Words: But fince I bave not yet had an Opportunity to cmploy $\int_{0}$ much Pains as I was defirous, and as was reguifite in this Matter, I fhall content myself witb baving made known my Intentions and Purpofes, and Say no more about it at prefent.

This Gentleman does likewife own, that this Branch lyes between the Fifth Pair and the Auditory Nerve; but adds, that he can't fee, why we may nor as well take it for a Branch of the Auditory Nerve, carried on to the Fifth Pair, as a Branch derived from the Fifth Pair to the faid Auditory Nerve: But whether we maintain it to be the firft or the laft with Monfieur Du Verney, it is certain, that this String has likewife a Communication with the Fifth Pair ; and that being put into Morion by Sounds, it cannot avoid continuing fuch Motion, both to the Fifth Pair and to the Audicory Nerves.

I have been more prolix in relating the Sentiments of the Principal Anatomifts upon this Matter, to fhew that this little nervous Cord has occafion'd very ferious Reflections among feveral Perfons, and that many have fufpected, that there is fomething ftrange and uncommon therein: And I Should nor have offer'd my own Opinions concerning the Operations of the faid Cord, and the Purpofes for which it feems to be made, were it not to convince the Atheifts and Unbelievers, or at leaft Weak and Wavering Chriftians, that they will find fomething in the Structure and Contrivance of this Sering, that may excite in them not only Admiration, but alfo Reverence for the adosable Maker of it. To propofe it therefore briefly :
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SECT. XXIII. The Fifth Pair of Nerves to excite tbe Paflions.

Ho w much the Fifth Pair of Nerves contributes towards exciting our Paffions or Inclinations, with refpect to the Intercoffal Nerves, which iffuing frequently with a double Branch out of the faid Fifth Pair, liberally communicate Springs to all the Parts of our Body, and caufe Motions therein, may be learned from the Words of this great Enquirer into the Nerves, Vieufens, p. 236 in 8 vo. who lays, That the Said Pair is not only carried on to the Eyes, Nofe, Palate, Tongue, Teeth, and all the Parts of the Mouth and Face; but that it likewife derives its Brancbes to every thing that is in the Breaft and Belly, and is even continued down to the Feet by the Intercoftals; Adding farther, p. 327. that this Communication of the Branches of the Fifth Pair is, among other things likewife, the Caufe why, purfuant to the various Motions that are produced in the Brain, all the Parts of the Body, and particularly of the Breaft, are differently affected, and the Signs of our Inclinations impreffed upon our Faces, which are altogether adapted to thofe Paffions that are moved; and accordingly by the Changes of our Countenances, the feveral Emotions, or Affections of Love and Hatred, of Joy and Sorrow, of Fear and Boldnefs, are clearly expreffed.

Sect. XXIV. The Dura-Mater produces the like Emotions.

Secondly, How much the Motions of the DuraMater, which encompaffes the Nerves, do likewife contribute to the producing thefe Paffions and Emotions in the Mind, is known to Surgeons when they souch the fame, and to Phyficians too very
frequently in the Diftemper called the Pbrenitis of Frenfey, in which it appears that by the pricking of this Membrane (whereby its Expanfion is augmented, and the manner of Motion alter'd (confufed Thoughts and extravagant Pafions, fometimes Weeping, then again a fudden fit of Laughter; one while Fear, another while Boldnefs and Anger, and innumerable other irregular Motions in Actions and Words, without any external apparent Caufe, are produced in the poor Patient. Now this great Inftrument of fo many Adtions, this Durw-Maiter, has many of its Nerves from the Fifth Pair, as the faid Vieuffens has thewn in Reveral Places; fo that that is likewife moved thereby.

SEcT. XXV. The Eigbtb Pair produces the fame Effects.

Tbirdly, I I may be likewife obferved from the faid Fieufens, p. 347. that in many Cales, the Nerves of the Eighth Pair, which the Ancients name the Wandering Nerves, or Par vagum encompafs thole of the Fifth Pair in their Operations; and confequently in many Places, by the interpoficion of the Nervous Branches, thofe of the Eighth Pair are inferied in the Intercoftals which proceed from the Fifth Pair. And how much therefore thofe of the Eighth Pair do likewife help io excite the Paffions, appears from the fame Author, $p .347$, and 348 . where he fays, since :be Eigbrb Pair bas a Communication wisb the Auditory Nerves about the Origin thereaf, we find ibe Reafon whby not colly different Pafjons are cxcited in the Soul, according to tbe differences of Scunds, but alfo wby tbe Heart and orber Paris, gea, evsen ibe wibole Body, are varioufi) affered tbercby.

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## S e c T. XXVI. The Auditory Nerve produces the like Effect.

Fourtbly, $\mathrm{W}_{\mathrm{E}}$ find the aforemention'd Monfieur Vieufens, difcourfing about the Auditory Nerves in the following manner; Thefe Auditory Nerves rife clofe to the Root of the Eigbtb or Wandering Pair, with which the fofter Branch of the Said Nerves runs along; whereby it comes to pafs, that there is fuch a great Sympatby between the Ear and the Bowvels, wwbich are provided with this Eigbth Pair. Tbat according to the variety of the Sounds, various Motions are produced not only ins the Brain, but likewwife in the Breaft, and oftentimes in the 2 whole Body, and thereby (viz. on occafion of thefe Motions) various Notions and Conceptions are excited in the Soul.

Befides all this, it is likewife found that the harder Auditory Nerve is likewife inferted in the Eighth and Fifth Pair, and alfo fends a Branch to the Dura-Mater, befides thofe which it gives to the Inftruments of Hearing. See Vieufjens, p.340, and 341.

SECT. XXVII. The Motion of the Chorda Tympani does likezvife excite the Pafjons.

From all which it is therefore plain, that by the Motion of the Fifth Pair, and by that of the Auditory Nerve, our Paffions are excited; and that the Fifth Pair produces this Effect both from itfelf, as it fends feveral Branches to the Dura-Mater, and a great many to the Eighth Pair, which Eighth Pair does likewife excite the Paffions: The Auditory Nerve alfo has the fame Effect, becaufe it is inferted in the Fifth and Eighth Pair, and in the faid Dura-Mater.

Now forafmuch as it has been already fhewn that the Drum-Membrane, which is moved by every Sound, can undergo no Motion unlefs the Audico ry Bones, and by them the Cborda Tympani E O (Tab. XI. Fig. 3. and C. 7. Tab. XII. Fig. 1.) be moved at the fame time; and forafnuch as Du Verney and Valfalua have both proved that this is a Branch lying berween the Fifth Pair and the'hard Auditory Nerve, and inferted in both; it follows, that chis Cborda being always moved by Sounds, borh thefe Nerves muft likewife fhare in the fame Motion: Wherefore it is Manifeft, that the Operation of this Cborda does likewife, among other things, confift herein, namely to bring the Body into Emotions or Paflions of Mind by thefe Nerves, or at leaft to difpofe and prepare it for the fame.

## S ect. XXVIII. Why the Hearing above all otber Senfes, is beft adispted to thefe Purpofes.

The Sight is commonly efteemed the moft excellent of all the Senfes; and Experience jtfelf has made it a Proverb, That one Witnefs, who has feen a thing, is more to be credired than ten that have heard it; which may be the reafon, perhaps, that the Hearing may be adapted by its Structure, even beyond the Sight, to ftir up Paffions and Emotions in Humane Minds.

But confidering that the Great GOD, according to his endlefs Wifdom and Mercy, has shought fit to propagate Saving Faith in his adorable Son by the means of Hearing, as well before he took upon him Human Nature, as particularly after that he left this World and enter'd into his Glory: It feemed to me (if one may prefume to fay any thing of the Wife Defign's of the Almighty, when they are not fully reveal'd to us) for thefe Reafons, that the Inftruments of Hearing have received fuch a different

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different Contexture from thofe of all the other Senfes. For, in order to adapt them for fo unconceivably a great Work, the following Properties are neceffary thereto.

Firft, That the Hearing, among all the Senfes, fhould have the Faculty to reprefent to the Mind ablent Things, either future or paft, by the means of the Sound of Words, and to make us comprehend them as if they were prefent; whereas the Sight, and other Senfes, are only affected by Objects that are prefent to them.

Secondly, That the Inftruments belonging to the Senfe of Hearing, have moreover fuch a particular Structure, whereby they are enabled to excire all our Paffions and Inclinations, and to awake the Powers of our Minds.

The firft Properry is proved by Experience ; the fecond has been already fhewn by the Defcription we have given of the Cborda Tympani, and the other Inftruments of Hearing, to which might perhaps be added, as another Caufe, Firf, that the DrumMembrane itfelf confifts of the Union of two other Membranes, one of which is the Skin of the Auditory Tube, and the other a Part of the Dura Mater which extends itfelf thereto. Secondly, that the Air which is put into Motion by Sound, can immediately affect the Dura Mater by the little Holes in the Cavity of the Drum, and by the Tube which is continued from thence to the Palate. Thefe Difcoveries we owe to Valfalva. But this we leave to the further Confiderations of the Learned ; Let it fuffice here, that it has been plainly enough proved, that thofe Inftruments that belong to the Senfe of Hearing are adapted to excite the Paffions.

Sect. XXIX. An Experiment to Shezv the Force of Mufick.

In the Hiftory of the Royal Academy in France, fir the Year 1717. (under the Head of Obfervations upoza Pbyficks in General) we find a Relation of a great Mufician, and in the Hift. of 1708. of a DancingMafter; the firft of whom was taken with a continued Feaver and great Ravings; and the laft with a very violent Feaver attended with a kind of Lethargy, and afterwards with Madnefs; and that both of 'em were perfectly reftored to their Senfes by Mufick.

We alfo find feveral Obfervations made upon Perfons that have been ftung by a Tarantula, a Creature found in Italy, of the Shape and Size of a great Spider, which has produced the extreameft Diforders in their Underftanding, Motions and Powers of Life; the Faces of fome turning back, their Feet and Hands as if they were Dead; others lying Speechlefs, or in deep Melancholy, reeking Solitary and Burying Places; fometimes digging Pitts and Holes, which they fill with Water, and wallow in the Mud thereof like Swine ; finally, after having undergone innumerable Miferies, their Diftempers have only ended with their Lives.

I fhall not enquire into the Caufes thereof, but we are taught by Experience, that this Great Evil, for which hitherto no other Remedy is known, can only be cured by the Sound of Mufick, of which different Airs and Tunes muft be played, according to the different Nature and Colour of thofe Tarantula's that have given the Wounds.

They that defire a fuller Information of thefe Matters, may be pleafed to confult what Signior Baglivi has faid about it.

Whilf I was writing this, a certain Learned Gentleman, and a Great Mafter in Mufick, did me the Honour of a Vifit ; and, as our Difcourfe occafionally fell upon this Subject, was pleafed to inform me that the famous Italian Mufician, Angelo Vitali, had related to him the following Scory, and affured him of the Truth of it: Namely, that a certain Player upon the Lute at Venice had boafted, that by his playing he could deprive the Hearers of the ufe of their Underftanding; whereupon he was fent for by the Doge, who was a Lover of Mufick, and commanded to put his Art in Practice before him; where, after having played fome time very finely, and to the amazement of the Hearers, he at laft began a mournful Tune, with a Defign, as far as he was able, to put the Doge into a melancholy Humour, and prefently after, he ftruck up a jovial one, to difpofe-him to Mirth and Dancing; and after having repeated thofe two kinds of Tunes feveral times by turns, he was order'd by the Doge, who feemed to be no longer able to endure thofe different Emotions which he felt in his Soul, to forbear Playing any longer.

Now that fuch fudden Variations in Tunes, by which Men are in one Minute's time render'd very Sorrowful, and the next no lefs Merry, do produce ftrange Effects upon our Minds, may eafily be conceived by thofe that have ever felt the Power of Mufick from an able Hand: At leaft, it is very plain from hence, and from numberlefs other $\ln$ ftances, how much the Senfe of Hearing contributes towards exciting the Paffions.

## SECT. XXX. The Force of other Sounds.

However, let no body think that nothing but good Mufick is capable of exciting Paffions and Diforders in the Minds of Men, fince we have feen the like Effects produced by other Sounds. Every body can furnifh Inftances of the extraordinary Emotions and Paffions which the Noife of a Drum, and the Difcharge of Guns, do excite in the Souls of thofe that have been in Sieges or Engagements by Sea or Land.

Phyficians likewife meet with many fuch Inftances in their Practice. Thus we fee Women that are troubled with Hyfterical Fits ofrentimes upon the fhutting of a Door, the falling of a Book, or any other unexpected Sound, very much difturb'd and frighten'd, fo as to ftart or leap at it.

I have met with fome, that being troubled with this grievous Diftemper, are not in a continual Fright, but complain very often, that they fanfy they hear the common Voices of Men juft as if they were the fhrill Sounds of a Great Bell continually ringing in their Ears, which made them ready to faint.

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# CONTEMPLATION XIV. 

## Of the Senfes of Tafting, Smelling and

 Feeling.$S_{E C} C^{\prime}$ r. I. Of the Neceflity of the Tafl:

NTOW as the great Creator is wonderfully Wife and Gracious in adapting us to the Senfes of Seeing and Hearing, he is not lefs fo in the Manner by which he makes our Meat and Drink; the two neceffary Supports of a decaying Life, fo agreeable to us.

It feems very unreafonable and improbable, that any body fhould be negligent in the feafonable Ufe of Food; but, unlefs it had alfo pleafed the Goodnefs and Loving Kindnefs of our adorable Creator, to beftow upon us the Senfe of Tafting, and thereby to render the trouble of Eating and Drinking grateful and pleafing to us, there feemed a Danger that many People would havé confider'd it as a Burden and Slavery, and would therefore have often let it alone, at leaft, they would not have ufed it in due Time or Quantity. And this will not ap$p$ ar ftrange to any Body that has ever obferved wich tiow much Averfion, and many times with Loashing too, we are brought to the ufe of Medicines, which, with refpect to the neceility of 'em, do far exceed Food itfelf.

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## Sect. II. The Seat of Tafting is in the Mouth.

No w can any Man think that it happen'd without the Widdom of the Creator, that the Senfe of Tafting fhould be juft placed in the Mouth, in which all Food is at firft received, mafticated, or made fmall by Chewing, and moiften'd with Spittle, and no where elfe?

## S E C T. III. Sereral Notions about the Inftruments of Tafting.

But, in how great Darknefs the Ancients were, with refpect to the true Inftruments by which this Senfe of Tafting is performed in us, and how doubtfully and varioully even the Modern Enquirers have writ concerning them, may be learned from the Letter of Malpigbi de Linguâ; fome placing the true Inftrument of Taft in the upper Membrane of the Tongue; others in the fpungy Membrane thereof; others again in the Nerves that are fpread throughout the whole Tongue; fome in the Almond-Glands, and their extended Membranes; others in the Throat; a few in the Pallate, which laft have been entirely cunfuted a few Years ago, by the Learned Bobnius, Circul. Anat. p. 375. At prefent moft People place them in thofe little Protuberances, which they call the Papille or Nipples.
SECT. IV. The Inftruments of Taft.

W e fhall not let ourfelves farther into this Matter, which perhaps may be hereafter cleared up by more Experiments, but only fay, that the laft of the above-mention'd Opinions is efteemed the trueft, by the greateft Enquirers into Nature ainong
among the Moderns. We fee then, that the Structure of the little Nipples appear peculiar in the Tongue above orher Parts, and that they have fuch a fingular Form, as feems to be required for one of the external Senfes: fince it is probable, that in the Iegument of the Tongue, thefe Orifices were exprefly made in order to admit into them the Particies of Food moiften'd by the Glands, and to.convey them to the Papilla that lye there-under, whereby they are affected with that Senfation which we call Taft.

For which purpofe the accurate Diffections of the above-mencion'd Malpigbi and others, have thewn, that the Nerves of the Fifth and Ninth Pair, which are held in be the Nerves of Tafting, are inferted in thefe Papille afrer a particular manner, and feem chiefly to torm this whole Nerve and Papillous Body; accordingly (as it is likewife obferved by the fame Malpighius de Linguñ, p. I6.) we find, that the Nerves chat are adapted to one of the external Senfes, are at laft dilated into a flat and membranous Body.

Now in what manner foever all this is of ufe to the Senfe of Taffing, we may at leaft obferve here likewife, the wonderful Wifdom of the Creator, who has been pleas'd to lodge in the Parts of the Mouth fuch Inftruments as are proper to excite in us this fenfation of Taft; of which, tho' the Structure were perfectly, underftood by Anatomifts; yet the moft skilful of 'em all could never be able fo much as to guefs how the Soul would be affected. thereby, had he not before-hand been taught by con inual Experience, what it is to Taft a thing. And can any one fanfy that fo Neceffary, fo Wonderful a Texture derives its origin from meer Cbance, or the ignorant Laws of Nature?

SECT. V, and VI. Experiments to fhezs that the Taft is in the Palate.

The famous Enquirer into the Secrets of $\mathrm{Na}-$ ture, Malpigbi, has dilcover'd Papille or Nipples in the Palate, or Roof of the Mouth, and in the Cheeks alfo; fo that according to his Hypothefis, the Palate, being likewife provided with the true Inftruments of Taft, muft neceffarily have that Senfation alfo.

To this we may add, that the later W'ritings of the Profeffors Bergerus and Hoffmanus, publifhed fince the Year 1700 . do alfo pofitively afcribe the Taft to the Palate, affirming, that Pliny in his Natural Hiftory has done the fame; but they are particularly induced thereto by the afore-mention'd Obfervations of Malpigbi; and farther, by the account we have in the third Year of the German Ephimerides, of a Child of about 8 or 9 Years old, in lower Poictou, who in the Small-Pox loft his whole Tongue by a Cancer, and fpit it out by Piecemeal; infomuch that at laft there did not remain any Sign that he had had one. Notwithftanding which, this Child did not only Speak, Spir, Chew, and fwallow his Victuals, but could likewife Taft, by the remaining Structure of his Mouth; and (as the Author, who was a Surgeon of Saumur, fays cb. 8.) he could diftinguifh all kinds of Tafts very well; whence the Writer farther infers from Pliny, that the Taft muft alfo belong to the Palate.

Bur fince this is a thing in which Experience, as in all others, ought to be the Judge, and as the tryal hereof may be eafily mate ; Let a Man only take a lictle powder'd Sugar, Syrup, or any orher fweet Matter, and lay it upon the Tongue; and as foon as ever they are melted he will begin to Taft; probably, becaufe they then begin to penetrate
trate and fink into the Orifices of the upper Tegument of the Tongue, with the moifture of the Spittle, and fo irritate the Nervous Papilla that lye under the fame.

But if he proceeds farther, and endeavours to fwallow the fweet Matter when 'tis melted, and to that End, preffes it with the Tongue againft the hinder Part of the Palate, he will plainly find, that that Part is likewife affected with the Sweetnefs; and efpecially, if after fuch Swallowing, he prefently draws the Tongue back again to the Palate, keeping it down in fuch a manner that it cannot touch the fame, he will find, that when afterwards the Taft of the Sugar does act upon the Tongue a little more fenfibly, the Palate will be alfo more fenfibly affected with it for a time. From whereby, at leaft, of how little moment foever this Experiment is, all thofe difagreeing Notions feem to be over-thrown, and the Opinion, that the Senfe of Tafting is likewife in the Palate, is eftablifhed upon them.

## SECT. VII. The Inftruments of Smelling.

Now to pafs on to the Senfe of Smelling; Can any one without acknowledging the Wifdom and Goodnefs of GOD, obferve, that whereas the Bone of the Head is otherwife fo hard, the Nerves of Smelling have a Bone to chemfelves, which, in order to afford them a Paffage, is full of little Holes like a Sieve, and which is therefore called the Spongy or Sieve-like Bone; thro' which the faid Nerves tranfmit their little Threads and Branches (being there encompaffed by the Dura-Mater) to the Papillous Membrane or Flefh, as fome call it, which lines the Cavities that are in this Spongy-Bone, and in the cop of the Noftrils, and which Nerves are expanded therein, in order probably to com$\mathrm{U}_{3}$ pofe
pofe the Inftrument of Smelling ? For that this Inftrument, which produces Smelling, is not below, but at the top of the Noftrils, appears from hence? that in order to Smell, a drawing in of the Breath is neceffary, whereby the Particies of the Olfactory Matter being mingled with Air, muft ftrike with fome Force againft the Papillous Tegument, to produce the Senfe of Smelling: And every one that holds his Breath, tho' never fo little, can eafily experience, that tho' any Smell be brought under his Nofe, yet he is not affected with it, till he draws in his Breath again.

This Experiment feemed indeed too trifling and too well known to be mentioned here; were it not that a certain Learned and Ingenious Author had denied the fame. From whence again, as above, in the Bufinefs of Tafting, the Weaknefs of all that is Humane does but too eafily appear.

SECT. VIII. Convictions from the foregoing Obfervations.

Now, can any one that is endowed with Reafon deny the wife Difpofitions of the fe Inftruments, namely, that fince the Olfactory Particles are convey'd by the Air, the Inftruments of Smelling are to be found exactly in the Place thro' which the Air continually paffes and repaffes on the account of Refpiration? That they are placed juft over the Mouth to communicate to us, at the firft, by this Senfe of Smelling, fome Knowledge of the Qualities of Meat and Drink which we are about to ufe? That the Noftrils are broader at the Bottom, that they may receive fo much more of the Olfactory Parcicles; bui narrower at the Top, to the End, that by the Compreffion of thofe Particles, the Olfactory Membrane and Nerves may be the more powerfully affected therewith?

## Se c t. IX. The Senfe of Feeling.

BESIDE S the foregoing Senfes, the Inftruments of which are all difpofed in their proper Places, there is one more, which is called the Feeling, which is in a manner diftributed throughout the whole Body, efpecially, if we underftand thereby the Senfation of Pain: But if we do not extend it any farther than to that Power or Faculty by which, when we touch any Bodies without us, we are enabled to difcover the Roughnefs or Smoothnefs, the Solidity or Fluidity, and other Qualities thereof, we can only then fuppofe the Seat of this Senfe to be in the Skin. Accordingly, we know that this latter is diftinguifhed in the Latin Tongue by the Word Tactus, or Touching; and that when we would mention the Senfation of Pain, we exprefs it by the Word Senfus, and not Tadtus Doloris.

## S E C T. X. The Inftruments of Feeling:

Now that this laft, that is to fay the Touch, is only Seated in the Skin, which is naked and expofed to the Objects that are without us, is fufficiently -known to the Modern Anatomifts; as alfo, that there is in the Skin a Difpofition and Contexture analogous to that of the Tongue, which the diligent Malpigbi and others, find to confift (befides the Blood and other Veffels) of Glands, each of which has a little Receptacle or Hole that is open externally, and affords a Paffage to the Sweat and Perfpiration: From whence it comes, that there arife outwardly from the faid Skin little Pyramidal Protuberances, like Nipples, which are encompaffed and faften'd together by a Reti-for- ticula.

Thefe Papille or Nipples, are what have been of late Years, and with great appearance of Truch, accounted the Infruments of Feeling, becaufe the Microfcopes feem to inform us that they fpring from the Nerves, the Branches of which are inferted very thick in the Skin, and are more numerous in Proportion, than thofe that run to the Mufcles or any other Parts, as the great Defrriber of Nerves, Vieufeens, has fhewn in his Preface concerning them. It is likewife plain from hence, by the help of the Microfcope, that thefe Papillous Protuberances make the upper Skin rife in many Places, to the End, that it may be fo much the more eafily affected by the Contact of External Bodies.

## SECT. XI. Convictions from the foregoing Objervations.

How ufeful now this Senfe of Feeling is to Mankind in numberlefs Cafes is fufficiently known; and the more, becaufe every one that wants it, is in many Accidents difabled from preventing his Ruin; as has been found in one, who having loft the Senfe of Feeling, together with Motion, on one fide of the Body, and fetting too clofe to the Fire, was miferably Burnt before he was in the leaft aware of it. Can then an Atbeift ray, that he is not bournd to be very thankful for fo great a Benefit as this Faculty is, whereby he is immediately made fenfible of any violent Heat, and confequently enabled to avoid the fame and many other Inconveniencies? Or will he fay, that it is a fimple and ignorant Caufe that has beflowed this Senfe of Feeling not only upon one Man, but like-

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wife upon all, and fixed it not in one only, but in all the Parts of the external Skin.

Secx. XII. The Fingers and Palms of the Hand bave a more acute Sense of Feeling than other Parts of the Body.

Is it without Defign, that in thofe Parts in which we explore and feel external Objects, this Senfe is much more fine and cender than in thofe which we feldom ufe for that Purpofe; for it is known to every one, that a Man feels more accurately with the hollow or Palm of the Hand, or the tips or extream Parts of the Fingers, than in moft other Places?

And this is one of thofe Reafons from whence it is inferr'd, that this Papillous Body which lies between the Skin and the upper Membrane is the real Inftrument of Feeling : Since it appears by expefience (according to the Teftimony of Malpighi, and after him of Bobnius, Bergerus, and others) that in thofe places, namely, the Palm of the Hand and the Tops of the Fingers, which above other Parts are particularly ufeful in Feeling, there is likewife a greater Collection of thefe Papille or Protuberances, than in the other Parts of the Body, which are not fo frequently ufed for that purpofe. It is likewife oblerved by Bergerus, that thefe Papilla are much more numerous, as well as large, at the Tip of the Tongue, and in the Lips; and that thefe Parts do feel more accurately, as it is neceffary they fhould, to the end, that they may immediately difcover when the Food is 100 warm or prejudicial any otherwife.

## S E C x. XIII. Convietions from what bas been faid above, concerning all the External Senjes.

We do now here intreat all fuch as ftill feem to doubt of the Wifdom, Goodnefs and Power of their great Creator, yea, even the moft unfortunate and obdurate Atheifts, in cafe they can or will receive any kind of Inftruction, that they would ferioully confider with us this wonderful Difpofition and Structure of the Senfes, and the vaft Advantages accruing thereby, not only to one, but even to all Men who are in Health: And then let 'em fay, whether they can ftill maintain with a good Confcience, that the Greatuefs and Goodfiefs of Him that formed them, does not fhine out as brightly, yea, and more 100 in all thefe things, than the skill of an Artificer in the Conftruction of any curious Machine.
When he confiders that the Smell and the Taft do likewife ferve to inform us, not only of the good and bad Qualities of our Food, but that the Pleafure which we find thereby excited in us, is an inducement to undergo this daily and continual labour and trouble of Eating and Drinking; will he fay, that this happens by Chance, and that he is not at all indebted to Providence for all this? That is to fay, for fuch noble Exhalations and Perfumes that proceed from fo many Plants, Herbs. Flowers, Gums, Spices, and other Things; for fuch a variety of agreeable Tafts, which he daily enjoys from all thofe Eatables and Drinkables chat ferve for Food and Refrefhment to us.

When he fees that feveral Parts belonging to our Bodies, fuch as Bones, Nails, Hair, Teeth, fo far as they are naked, have no Senfation in them, and yet our whole Body is encompafs $\mathrm{s}^{3} \mathrm{~d}$ externally with a Covering and Skin which has the Faculty
of making known to, and informing us of every Thing that does fenfibly approach and touch it. Can he think fuch a Structure as this is brought about without any wife Defign, and will not any intelligent Perfon think it unconceivable?

When he confiders, that the great Wonder of the Sight enables him to contemplate the Sun, the Moon, and even thofe Stars that are at an unconceiveable Diftance from him ; and that this Senfe is adapted to an Enquiry into the Magnitude and Motion of fuch glorious Creatures, and to oblerve their Laws and Properties; that this Senfe of Seeing can impart to him the Knowledge of many Things that are out of the reach of all the other Senfes; that its Inftruments are of fo wonderful a Structure as has been already fhewn: That to the end, that nothing may be wanting to render this Senfe compleatly ufeful, the immenfurable fpace of the Heavens is every where filled with Light: And particularly to the end, that this Senfation flould not be produced in Men without Pleafure and Agreeablenefs, the unconceivable number of Rays of Light is divided into fo many kinds, either of Figure or Motion, as reprefent to us all vifible Objects with the moit pleafing Colours. Can he ftill fanfy, that there is no Defign nor Contrivance in all this; and that fuch a wonderful Order and Regularity of every Thing, with refpect to each other, whereby Light is thus adapred to the Eye, and the Eye to Light, are all of 'em the refult of Caufes working together without Order, and without Underftanding? Let him once again ask himfelf thefe Queftions in his moft ferious Retirement.

The rather, if he obferves, that the Hearing informs us of the Motion and Percuffion of Bodies; of which we oftentimes can get no Knowledge by ocher Senfes; no, not even by the Sight: That there-
therefore, fince the Light does only caufe us to fee fuch Objects as are before us, the Rays of is only moving in Right Lines; the Hearing warns us of Things that are round about us, and fuch as are fomecimes even concealed from the Sight, becaufe Sounds pafs thro' all imaginable Curvities.

Withour this Senfe of Hearing, how great would the trouble be in communicating our Thoughts to each other? What Inconveniencies would occur to every one in Learning of Arts and Sciences, in Trade, in Pleading and other Worldly Affiirs?

Now can any one be convinced from the Structure of a Watch, a Mill, a Houfe, and Thoufands of other Artificial Machines, that the Maker of them propos'd to himfelf fome End in the formation of them; and yet with a fafe Confcience impute to meer Cbance the amazing Texture of the Inftruments of Hearing? And the rather when he confiders this Globe of the Earth furrounded with an Ocean of Air, of which one of its Ufes is to convey Sounds to our Ears?

Let therefore one of the moft conceited Philofophers, one of the moft Strong Minds, in his own Opinion, or rather one of the moft to be lamented Atheifts, tell us here, in cafe he had always wanted one of his Senfes, for inftance, that of the Sight, whether, by the help of all his Philofophy, he could cver have known or learned what a fort of Senfation that was, or how Men are affected with that which we call Seeing.

Let him make known to us, fince the Bodily Inftruments of all our Senfes are all equally produced by, and do confift of the fame Bread, Water, and other kinds of Food, how it comes to pafs, that his Hand has not the Faculty of Seeing as well as his Eye; that his Foot does not hear as well as his Ear, altho' the Light and the Air may be made to fall upon thofe Parts in the fame Figure and Mo-

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tion. Can any one think, that their different Forms produce fuch Senfations? Let him then fhew us how they do it : Let him examine his Meat and Drink after all imaginable Ways, and tell us the reafon, why the fame Bread in the Ears becomes an Inftrument of Hearing, in the Tongue of Tafting, in the Nofe of Smelling, and in the Skin of Feeling: He mult refolve it all into the abfolute Will of that adorable Creator, who is unfachomable in thefe his Ways, and who communicates to our Souls the Knowledge of thefe Things, in fo wonderful a Manner. He muft therefore be ftark Blind that does not difcover Goo in all thefe Senfes.

Is there no Defign nor End to be obferved in all this? Let then an unhappy Atheift tell us,' if he had a mind to make himfelf or any other Perfon happy, and had the Power to do it, whether he would not endow them with every one of the Fa culties that are found in the fe Senfes: And in cafe he could have produced any Thing like them, tho' in a much lower degree of Perfection, by his Skill and Ingenuity, wherher he would not think it a very great wrong done to him, if fome Body, judging of his Performance, fhould not, or would not fee the Wifdom and Contrivance of the Maker therein. And can he fill remain infenfible of his own Blindnefs, who declines to acknowledge the fame in fo aftonifhing a Machine, as that of Humane Bodies? The rather, whilft he perceives, that in order to render all our Senfes compleat and perfect, Air, Ligbt, Plants, Living Creatures, and the whole Univerfe almoft, muft contribure therero.

If then the Contemplation of all this cannot induce him to acknowledge his Maker's Goodnels, and his own Obligations on thefe Accounts, with the utmoft Gratitude; let him bur confider with himfelf in what a deplorable Condition he would find

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find himfelf and every Thing befides, if Mankind were deprived of thefe Effects of their Creator's Favour, which appear in all their Senfes: And let him for once fuppofe, that there was a Man who having none of thefe External Senfes, did neither See, Hear, Smell, Taft, nor Feel. Now, tho' a Man were always to live thus, even in good Health; could he fufficiently exprefs the Miferies of fuch a State? He that rightly weighs it, would he not rather wifh to be Dead, or to have never been Born, or even to have been a Stock or Stone, than which he is but little better in fuch a State? Now if without this Mercy of God, the Mifery of every parricular Perfon would have been fo great; to what Shall we compare that of the vaft Number of Men, who together make up all the Nations of the Earth, in cafe there were to be found upon it no other Creatures, but Blind, Deaf, Infenfible, and fo forth?

Have we then beftowed upon ourfelves thefe Perfections of the Senfes? No certainly. Has then mere Chance been able to do it? By no means; for Chance is difpofed to Act as well one way as another; and yet we find, that far the greater Parr, yea, all found People, are born with all there Senfes.

Let therefore a miferable Atheift confefs, that he is not only ignorant, but that he muft likewife for ever remain $\mathcal{C}$, of the manner in which our Senfes are produced, and do operate in us. All of them confift in a Motion and Impreffion that external Objects make upon us; all of them confift of a Motion or Paffion of fome of the Parts of our Body; all of them confift of Inftruments produced by the fame Meat and Drink; and, according to the beft Philofophy, all of them feem to refuls only from a various Motions of the fame Matter.

Whence then proceed the different Conzeptions which we find in ourfelves, upon Seeing, Hearing, Tafting,

Tafing, Smelling and Feeling? Muft not then the Acheift, fince there can be no other Subterfuge, acknowledge that there is fomething Immaterial in us, which is the Caufe thereof? Let it be fo: But if it be Incorporeal, how can it be moved by fomething that is Corporeal? For there is nothing but Bodies and Motions, both in the Maters round about us, and in the Inftruments themfeives of our Senfes: Will he fay then, that a Soul cannot be moved becaufe it is Incorporeal? How then does it happen, that a Subftance, which can neither be moved, nor touched by Bodies, is yet affected by, or thro' the Motions of Bodies; and can See, Hear, Taft, Smell or Feel? For that it is fo in Fact, cannot be denyed.

I think we need not ufe any farther Arguments to drive an Atheift into a Confeffion of his total Ignorance. And if he drus not know how all there Things come to pafs, as his own Confcience muft convince him that he does not, how can he, if he would be taken but for a tolerably Wife Man, prctend to maintain it for a Truth, that a Thing, which he does not know how it happens, can be produced by the neceffary and ignorant Laws of Nature; Let him reflect upon all the Things moft ferioully with himfelf, bifore he proceeds any farther.

If then this is only to be afcribed to a Powerful, Wife and Gracious Creator, who, that has the leaft fpaik of Graticude or Generofity in him, can forbear owning thefe Benefis with a Thankful Heart? And even tho' it were an Atheift himfeif, could he perfift in Blafpheming a GOD that had accumulared on him fo many. Favours, and in denying all his Attributes, yea his very Exiftence, muft he not expect to feel at laft the Vengeance of that Power which he had fo long oppofed?

## SECT. XIV. Fartber Convictions from the limited Powers of our Serijes.

I have ofren contemplated with the deepeft $\mathrm{Hu}-$ mility, not only the afore-mention'd wonderful Structure, and invaluable Advantages of our External Senfes, but likewife the unfearchable Ways of our great Creator in determining and bounding the fame. The unhappy Philofophers may fanfy perhaps to cover themfelves againft the Stings and Reproaches of their own Confciences, by objecting, that fince fo Powerful a Being has fo bountifully beftow'd fuch Perfections on Mankind, by adorning them with the Faculties of the external Senfes, why has he not diftributed the fame in equal degrees of goodnefs to every individual Perfon, to which we fee fome of 'em afterwards attain, by the help of outward means?
In anfwer to which, we fhall not ftop here to fhew, that it does by no means agree with the condition of any one who is nothing but a Creature, to prefcribe Laws to his great Creator ; and in cafe a Pot fhould fay to the Artificer who made it, why haft thou formed me thus? They themfeives would deride the abfurd Queftion: This is certain, that not one of thefe Philofophers is able to produce the leaft Argument, to fhew that it is not much more equitable to confefs with Chriftians, that we muft only afcribe it to the Will of the Supreme Governor of all Things, that the Faculties of Men fhou'd not rife to the higheft Point of Perfection in this Life; and that his Wifdom referves this for fuch only whom, in the approaching Eternity, he will vouchfafe to make proper Subjects for knowing his Atrributes in the higheft degree of Glory; rather than to think it a defect in the Power of him, who mulf be own'd Infcrutable in the Things he has already done.

But let us likewife in our turn ask thefe Objectors anorher Queftion : muft they not own that it would be an undeniable Token of the vileft Ingratitude, if a Man, that had receiv'd from another w 1.0 ow'd him nothing, more Favours than he could have even defired or thought of, fhould obferve af-t-rwards that the Widdom of his Generous Benefactor might have extended itfelf yet farther, and that his Power was infinitely greater, fo that if he had thourht fit, he could have endow'd him with more noble Faculcies than what he had hitherto beftow'd upon him ; and thereupon make this unreafonable conclufion, that fince he had not given him all he could, he therefore ow'd him norhing for what he had already receiv'd from his liberal Hand?

Bat if all that we have already faid concerning the Senfes, be not fufficient to convince him, let us go one ftep farther, and fhew, that even she Bounds themfelves, within which the extent of the Power of outward Senfes is confined, do likewife contribute to make us more happy, than if they could be exicnded a great deal farther, as in this laft Age they are found to do, by the help of Artificial Inftruments.

Let us fuppofe, that our Eyes had the Faculty of our Modern Microfcopes; it is true, that they would fhew us a World of new Creatures; a drop of Pepper-water, or Vinegar, and the Seminal Matter of Creatures would appear like Ponds or Rivers full of Fifh; the Scum of flinking and putrified Liquors, like a Field full of Flowers and Plants ; the Mites in Cheefe, lise great hairy Spiders, and a Thoufand other Things in like Proportion; but it may be alfo no lefs eafily conceived what a Loathing of many Things, which in themfelves are orherwife very good and ufeful, thefe Swarms of Infects would produce in us, which per-

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haps would be more evident, if you had feen as I have, how fome People viewing the Mites in a piece of Cheefe thro' a Microfcope, and upon one of there exceeding fmall Creatures falling off, fuddenly fnatch'd away their Hands, for fear is fhould fall upon them, which, by reafon of the Smalnefs of the Creature, excited a general Laughter in fome of the Standers by; but in others, more grave Reflections on account of the Wifdom of God, who has been pleafed to conceal thefe Things from the naked Eye of Ignorant and Fearful People: And yet to blefs the Difcoveries of Men by the Inventions of New Glaffes, fo far, that the neceffary Means fhould not be wanting to fuch as endeavour to look into thefe Wonders.

Moreover, would thefe Philofophers even dare to defire, that their own Eyes fhould be endowed with the Qualities of the beft Microfcopes in cafe they underftood the Nature and Foundation thereof ? And would they judge themfelves more happy, by feeing an Object fo fmall in iffelf, magnified to fo large a Size? When in the mean time all thas their Sight could extend itfelf to, would be contained within more narrow Bounds than that of a Grain of Sand; nor would they be able to fee any Objects plainly and diftinctly, but fuch as were at no farcher Diftance from their Eyes, than one or two Inches: And as for all other Things that were more remore, fuch as Men, Beafts, Trees and Plants, to fay nothing of the Sun, Moon and Stars, thofe fublime Creatures, they would ejither be entirely invifible to them, or would appear ac leaft very confufedly ; yea, if all this were fo, and that the natural Sight could penetrate as far as the fineft Microfcopes, none that have ever experienced the fame can deny, but that, by the help of them, one may fee Bodies compounded of a Thoufand lictle Particles; and confequently, that in order to fee
every Thing truly, and in its Original or laft Parts; the Sight muft be ftill extended ineonceivably farther than fuch Microfcopes have yet been able to carry it.

Now, on the other hand, fuppofe our Natural Eycs to be great Telefcopes, like thofe that have enabled us to obferve fo many new Stars in the Heaveos, and make fo many new Difcoveries in the Sun, Moon and Stars, they would be again liable to this Inconvenience, that they would be of very little ufe in feeing the Objects that furround us, as they would likewife not a little obftruct the Contemplation of all other Objects upon the Earth, becaufe they would fee too much of the Vapours and Exhalations continually rifing from the Ground, which, like great thick Clouds, would hide every other vifible Matter; as is but too well known to fuch as ufe thefe lnftruments.

Thus likewife, if the Senfe of Smelling fhould be as acuce and nice in Men, as it feems to be in fome kinds of Hunting Dogs; no Perfon, no Creature, could ever meet us, nor could we pafs by any Footfteps of them without being ftrongly affected with the Effuria that proceed from them; and we Thould be forced to turn our Attention, tho' never fo much againft our Wills, and tho' we ought to apply it to more exalted Objects, I fay, we fhould be compelled to fix it upon thefe contemptible Matrers.

In cafe the Tungue fhould make us Tafte Food of the loweft favour, with as high a Senfation as now the ftrongeft and fineft Ragouts, or made Difhes do produce; there need no farther Proof to induce every one to confefs, that this alone would fuffice to render fuch Fuod very difagreeable to us, after having ufed it but a few times.

Could the Hearing fo nicely obferve all Soundss as it is now found to $\mathrm{do}_{\text {; }}$ when, by the help of the

Long Tube, or Speaking Trumpet held to the Ear, any Body Whifpers foftly into the Broad End of it; how little Attention would People have for fome Things? Certainly no more than we have when we find ourfelves in the midft of a confufed Noife and Bawling of a great many Voices, or the loud Peals of Drums and Guns. They that have ever been witneffes of the Inconveniencies that Sick People undergo by Hearing too acutely, will eâfily be convinced of this Truch.

If the Feeling were fo tender and nice in all the Parts of the Body, as we find it in the moft fenfible Places, and in the Membranes of the Eyes; muft we not own that we fhould be very unhappy, and fuffer a great deal of Pain too, by the touch of the lighteft Feather?

To conclude; can any Body reflect upon all this, without acknowledging therein the Goodnefs of his Maker, who has not only furnifhed him with fuch noble Perfections, as are the external Senfes, for want of which, he would not be better than a Stock; but who has likewife out of his adorable Wifdom, included thefe Powers within fuch Bounds, without which they would have been no other than burdenfome to us, and a perpetual Obftruction in the attentive Contemplation of greater Matters?

If it fhould appear to fome, that we have dwelt longer upon this Subject than is perhaps agreeable to 'em, let them be pleafed to remember, that our Principal Defign throughout this whole Work, is to reprefent to Infidels and Atbeits, the Wifdom and Goodnefs of their Creator, which flines out fo brightly in the external Senfes of Men, and the unconceivable Faculties, or Properties thereof even to thofe that are afraid of being convinced thereby; and in which the Adorable Author of all thefe Things has moft evidently fhewn that he ought to
be diftinguifht in an illuftrious manner from meer Cbance, and yet more, from Neceffary Laws, or from a Nature that works without Knowledge or Underftanding.

Nothing more feems requifite towards an irrefragable Conviction hereof, than that what all the Learned, as well as we, have advanced concerning the Senfes, fhould be filently, attentively, and impartially weigh'd: when perhaps he that has fo Bountifully beftow'd them, may vouchfafe to Blefs the Means for the Conviction of thofe who have hicherto doubted of thefe Important Truths.

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## CONTEMPLATION XV:

That the Union of Soul and Body is unknown to us: Convictions from thence.

SEcT. IV The Union of the Soul and Boly unknown to us: Convictions from thence.

NOW fince each of thefe External Senfes do lead us up to the Soul ; can there likewife be any Perfon fo unhappy, as truly to reflect upon this Wonder, furpaffing the Conception of all the Philofophers, this moft aftonifhing Manner, after which the Body is united to the Soul, without being thereby convinced of the inexpreffible Power and Wifdom of Him that made 'em? Of Him, who has fhewn himfelf in this, as well as in many other Things, after a glorious Manner, both Wonderful
and Adorable; who, whilf He thus Works in Ways unfathomable by all Men, does likewife compel even his Enemies to be Witneffes thereof.

And tho' others may think that they can form any Notions thereof; yet an Atheift muft confefs, that there is fomething in it which is perfectly unintelligible to him.

For fuppofe he fhould boldly maintain, that the Corporeal Matter (in which, however, he can fhew us nothing but Motion) has the Property of Thinking and Underftanding; let him tell us, and prove to us, what Compofition of Parts, what Force, what Swiftnefs, what Limits and Directions of Courfe, either according to right or crooked Lines, are required in Matter thus moved, to render it capable of Reafoning and Comprehending a Mathematical Demonftration. And we fhall not need to ask him, whether this furpaffes his Underftanding.

Or, fuppofe alfo, that he fhould, according to Reafon and Experience, affirm, that his Soul is Incorporeal; let him fhew us, how it comes to pafs, that a Soul being Immaterial in its Exiftence, and which, according to all the Notions we are wont to form of it, can neither touch nor be touched by a Body, and yet can be affected by, or tbrough, or according to the Motion of the Body (for we fhall not here difpute about the manner of it, that being not neceifary with refpect to Atheifts) and vice ver $\hat{\lambda}$, how the Soul can affect and move the Body, or at leaft adminifter Occafion thereto, which, for the foregoing Reafons, we need not now examine : So that by its mere Will, the Body being in good Health, the fretching out the Hand, for inftance, immediately follows; and if that Hand Mould be burnt, the Soul immediately feels Pain. Now if all this were not as certainly known to him, as the moft certain Thing in the World is, forafmuch as he can
be every minute convinced thereof, by repeated Experiments, would not he be tempted to look upon fo difagreeing Notions, and which have not the leaft Analogy to one another, as grofs Falfhoods and vain Conceptions of the Brain? Wherefore, whatever an Acheift may fanfy to himfelf, the man. ner of the Union of the Soul and Body muft always remain inconceivable and unintelligible to him.

1 know very well, in cafe we proceed no far: ther, that the great Difagreement, concerning the manner in which the Body is moved by the Will, and which has occafion'd many Controverfies among Great and Wife Men, muft be left undetermined by us: But neither is this the Place, nor yet the Time, to fay any Thing about it, fince we only write for the Conviction of Atheifts; whereas the others, how much foever they differ in their Opinions, do all agree in the Belief of a God.

And we don's think it fufficient to have fhewn here, that whatever an unhappy Philofopher, who owns no God, may fay or think concerning thefe Matters, it all terminates in being Incomprehenfible, if he will fatisfy his Ideas and undoubted Experiences; which was our only Defign at prefent.

Let the Atheift therefore learn in the terror of his Heart, that there lies an irrefragable Proof in what he finds in himfelf to be undeniable, that his Reafon and Ideas, as much as he relies on them, are utterly incapable to inform him of the juft Difpofition, and the manner in Acting of Things that exift without him, according to Truth; and then confider whecher it be fafe for him to perfevere in Blafpheming, or Denying a God fo incomprehenfibly Mighty and Powerful.

At leaft cin he, or any one elfe pronounce that the Things of which he acknowledges not to. underitand the manner of their Operations, are pro-

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The Relicious Plislefopier. duced by meer Chance? And can Chance, or any Caufe that is wholly Ignorant of what it is doing, and which works without Laws or R Lites, produce Things of fo great moment, and fo inforutable even to the moft penetrating Genius, fo Frequently, fo Conftanty, and with fo much Order? And what can the greateft Philofopher fay of thefe Things, otherwife than that Experiencing daily that fomething happens in himfelf, which if it did not, he fhould thint impofible, he is forced to own the Stamp of God's infnice Power, which is impreft on him, and upon all others, even thofe that deny or hate him, without their Concurrence, and againft their Will. And perhaps it is no wrong Conclution of theirs who maintain, that we do nor yet rightly underfland or know either our Soul or our Body, with refpect to their crue Na:ure and Properties. For if both of 'emi were fo fuliy known by us as fome Philofophers imagin, how is it poffible that any Thing can happen fo plainly and fenfibly between'em both, as every one experiences in himfelf, and yet is fo uninte!ligible, as to the manner of Acting, to all that have inquird into the fame; infomuch that none have been able to fay any Thing concerning them, which does not at laft terminate in an abfolute Incompreternfioitity?

## S E C T. II. Convicfions from tbe foregcing Refiefinions.

BEFORE we quit this Subject of the Soul, the greateft and moft Precious Gift in the World, whereby it has pleafed the infinitely Gracious Creator to render Men Happy: if an Atheift be net ye: fully conrinced how miferable he would have been himfelf, and all orhers with him, if Ged had not youchfafed the Ufe of any external Senfes, thereby excired to Thankfulnefs towards his Maker: Let him confides ye: further what would
have been the condition of Mankind, if none among them had been endowed with Underftanding. What is a Man to himfelf, and what would all the Riches in the World have been to a Man in fuch a State? We find an illuftrious Inftance hereof in the Hiftory of that mighty Monarch of the whole Earth, as far as it was then known, the great Nebucbadnezzar, who upon the lofs of his Underftanding was not only debarr'd all Converfation with Men, but being thruft out of his exalted Throne by his own Subjects, was forced to keep Company with the Beafts of the Field.

And now fuppofe the whole World fhould abound with brutal, raving-mad Fellows, or be full of Foo's and Ideots; or to exprefs it in a Term that often comprehends it all, of drunken Sots, that had lof the ufe of their Reafon; can any body reflect upon the unfpeakable (how fhall we call it) the fud and deplorable, or horrible and frightful Condition of all things, withour wifhing rather to be dead, than alive among fuch People? Now this invaluable Treafure, this precious Jewel of the Underftanaing, every one knows he is not able to beftow on himfelf. And can the imagin that he who indow'd him therewith, and that, without any help on his part, don's expect to be thanked for fo great a Benefit?

## SECT. III. The Bounds of this Union.

This Union of the Soul and Body is not only wonderful in itfelf, and in the manner in which it happens, but likewife in the Bounds and Limits which are prefcribed to it. We find it thus in the firft Place, that the Soul does not operate by its Will (however it be) upon our awbole Body; or rather, shat our awbole Body is not Subject to :be Soul in its Moi. थs, but only, as it fhould feem, thofe Parts that faid to act freely, that are moved according to the Pleafure of the Soul; whilft other Parts, which have their Nerves from the Cerebrum, and which do only ferve for Life and the Support thereof, as the Heart, the Arteries, the Stomach, the Bowvels, Orc. do by no means obey the Will of the Soul, nor, like the former, can be moved or ftope at Pleafure.

Secondly, Neither docs the Soul feel when every Part of the Body is acted upon, or affected. Thus we find, that befides the Hair and Nails, the Bones themfelves are likewife infenfible; all which make up a great Part of our Body: Not to mention that the Lungs are known to wafte away in many Men withour Pain; and that Chirurgical Obfervations teach us, that the Subftance of the Brain may fuffer very much, withour communicating any Senfation thereof to the Soul.

## SECT. IV. Convictions from thence.

Can now a deplorable Atheift think he has fo much caufe to accufe the Chriftians of Credulity, when he hears them make the following Conclufion from the above-mention'd Premifes: That fince no Body can juftly afcribe all this to mere Chance, working indifferently one way as well as another, this is a true and convincing Proof, that it can by no means proceed from a neceffary Series of Laws of Nature, always acting after one and the fame manner, that the Soul fhou'd have the aforefaid Reiation or Refpect to the Body: Forafmuch as the Wife Creator being defirous to convince us all, that He neither operates by Chance, nor is confined and determined by certain neceffary

Laws, but freely, and according to his own good Pleafure, has render'd fome Parts of the Body obedient to the Will of the Soul; and caufed others to move entirely independent thereupon; neverthelefs, thefe laft as well as the firft, are fo far fubjected to the Soul, at leaft related to it, that both the one and the other, fo long as the Soul remains united to the Body, but no longer, are enabled to perform their Functions, and remain without Corruption.

And that Atheift that will hearken to Reafon, feems particularly to be obliged to juftifie a Chriftian in the aforefaid Conclufion, fince it is jult thofe Parts that ferve for the fupport of our Life, fuch as the Heart, Stomach, and other Entrails that are not only, not fubmitted to our Will, but moved unknown to it, by the Power of the Great Creator, that he may convince us of our Dependence upon him. Whereas, on the contrary, the Motion of fuch Members as the Tongue, Hands, and the reft, are left to the Difpofition of our Will, that they may ferve to Acknowledge and Glorify our Great Benefactor in our Bodies alfo, which is what He with fo much Juftice requires of us.

> Se c T. V. The Imagination and Memory.

There would yet have been fomething fill wanting to the Perfection of a Humane Creasure, notwithftanding this wonderful Union of the Soul and Body, if we could not have exercifed the Underftanding and other Faculties of our Souls upon fuch Objects only as are prefent or before us. Nor would our Judgments and Inferences or Deductions have been of much weight, if we could not have compared prefent Things with any other paft or focure.

How fhould we have been able, for inftance, to have made any ufeful Difcoveries about the Laws of the Sun's Motion, in cafe nothing thereof were known to us befides what we could learn from things prefent? For as to thofe that are abfent, fuch as things patt or to come ; the external Senfes, tho' they be the firft Helps of Enquiring into all Bodily Matters, cannot inform us the leaft thereof. Even the Hearing itfelf, which feems otherwife to be in fome meafure adapted chereto, would yet be entirely unfit and ufelefs to this Purpofe, without the other Powers, of which we are now about to Treat.

Our Gracious Creator, in order to multiply his Wonders upon us, and to render us compleatly Happy, has been pleafed to fupply this Defect likewife, and to lodge in us a Power of reprefenting to the Underftanding, even paft, future, and all abfent Things. The firft of thefe Faculties is named by the Philofophers, the Memory; the laft, the Imagination.

Whether it be now that thefe owe their Origin to certain Motions of the Spirits or Humours, or Membranes, produced by our external Senfes or Thougbts, and leaving behind them Traces and Footfteps in the Brain, which give our Souls an occafion to think after fuch a manner, as if the things reprefented to the Imagination or Memory, were really prefent: Or whether there be any other caufe thereof; this is certainly true, that the endowing Mankind with fuch a Power, does far exceed the very wifeft Difcoveries. And in cafe we were not affured thereof by Experience, who could believe that it was poffible for any Man to reprefent to himfelf things having no Exitence, as if they were Exitting; Dead things as Living; and thus to render an Object as Prefent, which is either Abfent, or even not Exifting at all?
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## CONTEMPLATION XVI.

Of the Humane Paffions or Inclinations, and briefly of Procreation.

## S ECT. I. The Paffons and Inclinations.

MA N, being thus bountifully furnifhed by the Gondnefs of his Creator with all the abovementioned Powers and Faculties, feemed to be placed upon the higteft degree of Happinefs. His intelligent Soul, united after fo wonderful a manner to his Body, exerts its Conceptions and Judgment upon all Matters that occur to it ; his external SenSes impart to him the Knowledge of material Beings; his Imagination and Memory reprefent to him every thing that is ablent, either paft or to come; his Hears and Arterics beat; his Powels, and all his other Parts that are neceffary to Life do, by the Power of his Creator, continually difcharge their Functions, without giving him the leaft trouble during the whole Courfe of his Life; the other Limbs and Members are obedient to his Will, enabling him to glorify his Maker with Thankfulnefs, and to be ufeful to himfelf and his fellow Creatures.

Now this laft might feem to be in fome manner inconvenient to him, it being the only Motion that can occafion Trouble or Wearinefs to him. But to the End, that he fhould not faint nor be difcouraged nefs, or that of others who are dear to him; it has pleafed the fame Gracious GOD not only to enable all the Powers of Man to be concurring thereto, bur, which is a greater and particular Benefit, to be concurring therein with Pleafure; and accordingly, to endow him with various Inclinations and Paffions to ftir him up to perform, with Zeal and Eagernefs, all that is neceffary for him to do.

Thus we find in ourfelves a Defire or Longing and Hope for that Good which we confilder as approaching to us; and $70 y$, when we have obtained it, and Love towards it, when we are poffeffed of it: And on the contrary, a Fear for approaching Evil; a Sorrow when it comes upon us; and Hate againft the Caules that make it keep the Poffeflion of us. Now, not to give a Lift of their Names here; Can any Man contrive or invent Tharper Spurs to induce him to feek after that which he efteems good to himfelf, and thofe that are dear to him, and to avoid all that he thinks Evil? And how ftrongly a Man can be excited thereby, daily Experience teaches us; as well as the deplorable Examples of thofe unhappy Men, who by a corrupr Judgment, cmbracing Good for Evil, and Evil for Good, make a wrong ufe of thefe fo neceffary Paffions.

Now to repeat our Queftion again, Can thefe Incitements and Allurements be lodged in us by mere Chance, or any thing that has neither Knowledge nor Underftanding? Which, in order to render us more happy, do not only induce us to perform our Actions with fo much Eagernefs, but do likewife, upon many occafions, and even without our Will, give the Inftruments of our Motions more Life and Energy; or, have not here all reafonable Men juft caufe of Thankfulnefs for the Mercies of their Creator, who, confidering us as
the Mafter-piece of all his Works, would not fuffer us to want thofe Powers, whereby we are enabled to promote the Welfare both of ourfelves and fellow Creatures, even with Pleafure and Satisfaction.

> SECx. II. The Difference of Pafions and Inclinations.

AN D if any one fhould fanfy that this Queftion fuppofed too much, in order to demonftrate, that the Wifdom and Goodnefs of the Creator only, and no accidental or ignorant Caufes have any Place in thefe Paffions: Let him but reflect upon thefe two or three following things with us; from whence the Government of GOD, and the Execution of his wife Purpofes, feem to Thine out fo brightly, that even an Infidel, or any other that doubts of it, if he would but ufe his Reafon, cannot with any Foundation, infift upon a fuller Proof thereof.

For were there no GOD that directed every thing according to his Providence; how comes it to pafs that Men whofe Bodies and all the Humours thereof confift of the fame Matter do yet, in cafes where the Intereft of Humane Society requires, differ fo much from one another, in their Paffions and Inclinations; infomuch, that each of 'em do with Pleafure embrace fome particular Bufinels (with a view to their own Eafe and Advantage) in order to pleafe and profit their Fellow Creatures?

Now fince no Man's Life is long enough, nor no Body's Opportunity or Power great enough to provide every thing for himfelf neceffary to his Support and well Being; can we not herein difcover a Providential Direction, to render Men Affitting and Helpful to each ocher in their particu-
lar Wants, that each one, out of Choice and Inclination, is driven on, even tho' his own Gain be chiefly in view, to concur, as far as in him lies, thereto? Thus it happens in our Fancies to particular Studies; one finds himfelf inclined to that of Divinity ; another to the Study of Laws and Cuftoms; a third to Phyfick; a fourth to an Enquiry into the Nature and Works of GOD; others, to the reading of the Tranfactions and Revolutions that have happen'd to the World in former Ages, in order to apply that Knowledge to the Prudent Conduct of Affairs in their own Time. Many again find themfelves inclined to quite other Sorts of Employments; fuch as don'c fo much care for a Speculative Life, take more pleafure in Trades and Merchandizing, which likewife they make Choice of according to their different Paffions and Humours. Others betake themfelves to the feveral Arts of Painting, Building, and to Manufactures, of which likewife the kinds are both Different and Numerous.

Now can any one think, that it is the refult of mere Chance, that Men, from all of whom, by reafon of the Similitude of their Structure and Food, one fhould feem to expect nothing but an Identisy of Inclinations, do difcharge their Affairs and Functions fo varioully? And as ftrange as this may appear to every one at the firlt view, yet does not Experience teach us, that 'ris of abfolute neceffity to all Mankind that it fhould be thus? And in cafe all of them were inclined to the fame thing, for inftance, if every Scholar fhould apply himfelf to the fame Studies, every Merchant deal in the fame Wares, every Artificer in the fame Handicrafr, there would not only be a Failure, but likewife an entire Deprivation of the Eafe and Convenience of the whole World.

Now can we nor fee in all this, the Direction of a Supreme Governour plainly Thining forth, who, to convince all Men of his Goodnefs and Mercy, caufes them to live for the Benefit of each orher, and what we cannot do for ourfelves, adminifters by others to us; and has implanted fuch differing Inclinations in Humane Creatures, notwithftanding the little Difference there is in their Production, Structure and Prefervation ; to the end that we may more clearly perceive his Wonder-working Hand, and that we fhould not aforibe thefe fo neceffary Faculties of the Mind to meer Chance, or to the Ignorant Laws of Nature ?

## Sect. III. The Agreement of the Inclinations and Pajfions.

Againstall this, a miferable Philofopher that apprehends nothing more chan to be forced to acknowledge a Supreme Director of all Things, and confequencly to meet with an undoubted $\mathrm{Pu}-$ nifhment for his Blafphemy and Atheiftical Behaviour, would endeavour to object this Subterfuge and Evafion, namely, that we are taught by Experience, that-fuch a great Difference of Paffions are innate, and brought into the World with all Men; and therefore, that they only flow from the particular Contexture of Bodies, $\& \sim$.

But to convince thefe Perfons that this, and every thing befides, is rather the effect of a wife Direction, than of mere Chance or the ignorant Laws of Nature; let them go a little farther with us, and ask themfelves the following Queftion; In cafe this variety of Paffions does proceed only from the Seructure of Men, how comes $\mathrm{it}_{\text {, }}$ that the contrary has place where the diverfity of Inclinations

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 would be hurtful to the Publick? Why have all Men living one and the fame Defire to eat their Food with Pleafure? Why are all Men, and even all ocher Living Creatures, hurried on with the fame, and fometimes, ungovernable Paffions, to Ge neration or Procreation? And laftly; Why have they the fame Love to their Children?Certainly no Body will deny that unlefs thefe Paffions were found to be alike in all Men, and in cafe there were room here for fo great a Difagreement as in the others; or, to carry on the fame Comparifon, if the Defire towards Food were only found in a few Perfons, Food icfelf would be no otherwife ufed by many, than as a Medicine againft that Death which was to be the Confequence of an unfatisfied Hunger. Now, with how much Averfion and Loathing this happens in many, even where the Diftemper renders it moft neceffary, is fufficiently known, and from thence as eafily infer'd, that many People, abftaining too long from the ufe of Food, lofe the Powers and Faculties of Digeftion. If likewife there were as few inclinable to Generation, as we fee there are who choofe the fame way of Living and Employments, muft it not be confeffed that the World would be foon Naked and Difpeopled? Again, if the Love of Parents to their Children were fo uncommon, as the Inclination of Men to one and the fame Trade or Calling, how many poor Creatures juft born, would for want of Neceffaries, meer the End of their Lives almoft as foon as the Beginning?

And, to conclude the whole with one word, Let an obdurate Atheift put this Queftion to himfelf, and Anfwer if he can: Whecher he does not therein difcover the Wifdom of a Great Director? And whether he can, with an entire Conviction,
and without being contradicted by his own Con: fcience, affirm, that it appears to him to be merely accidental, that there is found a variety of Inclinations in Men, where fuch a variety is ufeful to Mankind; and on the contraty, that the Inclinations and Paffions are there only uniform where fuch a Uniformity is neceffary; and where a Difagreement would Difpeople and Defolate the whole Earth? At leaft, let him tell us, whether, if he were to have regulated thefe things for the good of the World, and with the utmoft Prudence, he could have fallen upon a better Method?
SEC. IV. The Lave of our Country.

What necefficy can be deduced from any natural and ignorant Caufe, from whence it fhould follow, that all Men feel fuch an over-ruling Inclination towards the Country in which they are born? And how is it poffible, that the cold, barren, Northern Parts of the World, where befides, a great Part of the Winter is nothing but a difmal Darknefs, fhould not yet be Difpeopled of their Inhabitants; or, that they fhould not yet have betaken themfelves to the fine Southern Countries, where the Air is milder, and all the Neceffaries and Refrefhments of Life more plentiful, long before now; and, which is more, that many Men after having tafted the Pleafure of the latrer, fhould yet freely recurn to the former: I fay, how can this be accounted for, without refolving it into the Will of the Great Director, that Men Mould likewife inhabit even fuch Parts of the Globe?

## SECT. V. The Conitempt of Dangers.

If this be not fufficient to convince our Atheift, let him confider in the laft Place, whether he can, upon his Principles, account for that dreadful Thirft after Honour and Glory, which all Ages have beheld with Amazement, in the Actions of their Heroes; and which hurries Men on, and makes them run headlong into the greateft Dangers, yea, even Death iifelf, to which Humane Nature has the greateft Averfion.

Not to mention thofe whom their Wants oblige to follow the War, can any one reflect, without wondering, that Great Men and Illuftrious Perfons (who are otherwife in a Condition to enjoy all the Pleafure of the World in Plenty, and at leaft, to die an eafie Death in a good old Age) Chould yet expofe themfelves with fo much Zeal and Bravery to the innumerable Dangers of War, where they daily, and by a terrible Experience, find that Lot to fall to others, which to Morrow, or perhaps fooner, may be theirs; alfo of being nain, or at leaft rer.der'd miferable all the reft of their Lives, by their Wounds and Lofs of their Limbs?

If now it flanuld be anfwer'd that the Generous Thirft afrer Honour fubdues and ftifles all the contrary iNotions in their Souls, yet even this proves a Supreme Direction, which, by fixing the fe Noble Sentiments in fuch great Subjects, brings about its own wife Ends and Purpoles. But forafmuch as this Paffion, how frongly foever it affects thofe brave Heroes, is in iffelf entirely inept thereto (for no Body can flatter himfelf that all the ee Efforts to get Honour fhall infure him againft a CannonBuller, or any other fatal Wounds; ) And as much as they value the Praife of Courage and Bravery, yer Dying is Dying, and confequently a thing to

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be feared in itfelf; and certainly as high as the Glory of Arms may be extolled, after Death, they can reap no Pleafure from it, the rather fince they can not be ignorant that the Honour which Men get by dying in the Field feldom accompanies any but fuch as have been great Generals; whilf orhers who have not attain'dे to fo high a Degree, altho' Brave and Valiant in their Lives, are involv'd in an utter oblivion as foon as dead, their Name and Fame being bury'd in the fame Grave with their Bodies, whilt norie but their Friends or their defolate Widows and Orphans lament their fudden and immature End.

But notwichfanding all this, we fee many, and fuch as have but a finall fhare in the acquir'd Hnnour of a Victory, in cafe they fall and dye in the fame, and who might otherwife have fpent their Lives with Eafe and Pleafure, abandon themfelves to the Perils of War.

Now, to afcribe the Caufe of fuch a noble Courage and Bravery to meer Chance, is a very ungrateful and unworthy Treatment of thofe great Men, whofe Wifdom has not given the World lefs matter of Admiration, than their Courage.

To deduce it from ftronger Paffions, is likewife not poffible, as we have already thown, becaufe the fear of Death, provided that they may live without Shame or Mifery, is the ftrongeft of Pallions in all Men whatloever. What Reafon then can be thoughr of for all this, fave only the Supreme Will of the great Director of all things? who has infufed into the Souls of fome Men, whom his Providence has marked out for great Events, the right Principles of a true Generolity and Courage; letring them fee that he has chofe them out of $2 n$ infinite number of other Perfons, and laid this Obligation upon them of oppofing Tyranny

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and abflute Power, and of reftoring to their own Country, and to their Friends and Allies, thofe deareft Bleffings of Religion and Liberty, even at the hazard of their own Lives. And who again has made others, tho they propofed to themfelves no other End than the gratifying their own Inclinations, or at leaft, acquiring Riches and Glory, like many of the Heathens, to defpife Death and Danger in a mott unconceivable manner; whereby he has compelled them, tho' infenfible thereof, to be fubfervient to his Providence and Adorable Purpofes.

> SECT. VI. Convictions from the aforegoing Obfervations.

I e r him that has hitherto doubted of God's Government, ferioufly reflect upon this Great Wonder, and fee whether he can deduce that which he finds true by Experience, of the Courfe of thefe Paffions and Inclinations in Mankind, from an accidental Concurrence of Nerves or Fibres, or Humours of the Body; or from any Laws of a ftupid Nature, unable to propofe to itfelf the leaft Defign in all its Works; And then tell us how it can come to pafs, that upon fuch Principles, thefe Functions fo neceffary and ufeful to humane Kind, and at the fame time fo wonderful too, can be fo conftantly difcharged; and that in all Ages the fame Steadinefs and Uniformity has appeared therein, which can never be applied or attributed to meer Chance?

## SECT. VII. Tbe Defrre of Procreation.

Can any Body avoid feeing from all that has been faid, that the Inclinations inherent in Mens Minds, as corrupe as they be, and applied ofeen to wrong Objects, owe their Origin to fomething more than Humane Wifdom ? Which, having thought fit to render them fubfervient to his great Purpofes, caufes them to prevail over all Obftruations; to which end, he has vouchfafed to qualifie the moft Bitter Things, which in their own Nature can produce nothing but Averfion and Terror, with the moft defirable Charms, and to render them, as I may fay, Palatable, with an agreeable Sauce to incline our Paffions thereto, notwithftanding all the aforefaid Inpediments; and to the end, that we may put this paft all doubr, let the Atheift, befides what we have juft now faid, about the Contempt of Dangers; let him, I Cay, turn his Eyes with us upon chat Inclination which Men feel in themfelves towards Procreation.

Now if it were not the Will of the great Diredor of all Things, that the Race of Men, which would otherwife end in each Individual, and be quite extinct with the Life of one Man only, fhould be fupported in their Pofterity ; How happens it that all Living Creatures are hurried thereto with a Paffion exceeding all others? But to proceed farther, How is it conccivable, when in the bearing and bringing forch of Children, Women do not only undergo fo much Trouble and Pain, but frequently vifible Danger of Death, that there flould be one only to be found, that would venture the fame a fecond time affer once having made the terrible Experiment? I fay, how comes all this to pafs, if it had not pleafed the great Creator to
confirm the Words which he fpoke in the beginning of the World, Gen. i. 28. Be fruitful, and multiply, and replenifh the Earth. And thus to fupport the Truth of them by a never-failing, Experience. In vain do we feek for other Reafons thereof, nor can any thing feem more unreafonable than to aferibe this to Chance or Ignorant Caufes, efpecially if we weigh the following Circumftances: Can any one imagin, that it is without Defign, that there fhould be made juft two forts of Perfons in every thing alike to each ocher, and different only in thofe Parts that are required for Generation; and thar, befides thefe two, we know well enough, that there was never any third?

## SECT. VIII. Why we bave not treated more fully and minutely upon the Bufinefs of Generation.

Whoever reads this will perhaps thing it ftrange that we have not fpoken more largely concerning the Affair of Procreation, fince the Providence, Wifdom and Power of the great Creator fhines forth fo irrefiftibly and glaringly in that whole Matter. But they may be pleafed to know, that the fame Reafons that made us keep filence, or fpeak fparingly upon many other of the foregoing Subjects, fuch as the manner after which the Separation of the Humours is made, the Tumifaction or fwelling of the Mufcles, the Ufes of the external Senfes, the Limits of the fo called Senforium Commune, and many more, have induced us likewife to oblerve the fame Caution here; viz. becaufe the Truth has not yet been confirmed by Experiments in fo fure a manner, but that there ftill remain a grear Variety and Difference in Opinions among the moft learned Men concerning them.

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## SECT. The Principles or Stamina of Living

 Creatures.Whether it be then, that the firft Principle, or Stamen, of Men are to be fought for among the Animalcula, or among other Particles without Life indeed, but put into Motion (for thus differently are they defined by fome of the moft famous Enquirers into Nature), which, by the help of Microfcopes are difcover'd in Semine Mafculino, of all Creatures that have been hitherto examined: Whether it be to be found in the Eggs of the Females, as others pretend ; or laftly, whether it be that the Coition of both the Sexes is neceffarily required to the Formation of this Stamen; all which we do not pretend to determine here: This is however fure enough, and afrer fo many Enquiries, is received by all the Modern Philofophers, that all Living Creatures whatever proceed from a Stamen or Principle, in which the Limbs and Members of the Body are folded and wound up as it were in a Ball of Thread ; which, by the Operation of Adventicious Matter and Humours, are fill'd up and unifolded, till the Structure of all the Parts have the Magnitude of a full-grown Body. In order to be convinced thereof, the Reader may confult the Obfervations of the great Harvey, both upon Men and Bealts, both the Viviparous, or fuch as bring forth their Young alive, and the Oviparous, or thofe that lay Eggs; in his Book de Generatione Animalium. And after him the accurate Malpighi, in the Experiments he makes upon the Hatching of an Egg, and the Formation of a Chicken in the Egg.

Thus we find the firft of thofe fpeaking of it in his 15 th Exercitation; That the Stamen, to the beft of his Knowledge, before be bad obferved it, was acpounted by no kody te be the fret Origin of tbe Cbickers.

And Malpighi fpeaks of it in the following manner: Wherefore it muft be onvned that the Stamen of a Cbicken is already in the Egg before the Hatching : and therefore muft bave proceeded from a Higher Caufe after the fame manner, as in the Eggs of Plants. Thus he makes an entire Analogy berween the Stamina of Living Cratures and the Seeds of Plants: In which laft he is likewife wont, for the fame Reafon, to mention fome Parts by the Name of the Uterus, Placenta, and the like, which are only proper to Living Creatures.

It fhall fuffice here, to have quoted thofe two great Men for the Confirmation of the Truth of what has been before-mention'd, fince they feem to have been the firft Difcoverers thereof: And fince all the Great Naturalifts of this $\Lambda$ ge have been convinced thereby, and by their own further Experiments, that the Beginning of all Creatures confifts in a Stamen, as may be fhewn in numberlefs Places of their Writings, which thofe that pleafe may have recourfe to.

1 would have been fomething more particular upon this Subject here, which feems to be the proper Place for handling it: But forafmuch as che encreafe and growth of Animals from thefe litcle Stamina, may receive a great Light from thofe of Plants, which may be found in every Seed; I chufe rather to refer my Reader to Contemplation XXIII. where I exprelly treat of that Subject; or racher to the Obfervations upon Plants, of thofe famous Philofophers. Meffieurs Grew and Malpighi, where he may find Experiments enough, to fhew that a Plant is produced from: Stamen, and a living Creature from a like Stamen; or, to fpeak in their ufual Language, is unfolded, as we fee in a Silk-worm, where the Butterfly comes out of the Aurelia, in which all the Parts of the Butterfly are involved or roll'd up. See Malpigbi de Bombyce.

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And fince we have already an Experimental Certainty, that a Male and Female Creature are neceffary toward the Procreation of another of the like Species; 1 leave it to thofe that have the Opportunity of carrying their Enquiries farther, what is performed by each of 'em in particular, towards Generation; as likewife, whether in the Egg of a Female, the folid Parts of the Stamen of the future Creature are to be found; and whether it be impregnated and vivified by the Sermen Mafculinum, and brought into Motion agreeable to the Laws of the Seminal Matter.

This feems to have acquired fome degree of Probability; forafmuch as we know that the Body of a Man does not only confift of Solid and Fluid Parts, but is likewife endowed wihh certain Laws, purfuant to which all the Parts are moved; fo that thereby the fame Bread, which at firft according to the Laws to which 'was Subject in the Plant, was Wheat or Rye, being afterwards eaten by a Pullet, does, according to orher Laws, become Pullets Flefh, and finally this Pullet being again Converred into Humane Food, becomes the Fleth of a Man: and fo in other Cafes.

This might caufe fome Sufpicions, whether that which is difcover'd by the help of a Microfcope in Semine Mafoulino (which the accurate Verbeyen, Part II. p. 69. afferts to be Particles put in Motion, and not the Stamina of Living Creatures) may not be that Matter, which, according to the Laws that the great Creator of all Things has produced in every particular Man and Beaft, being put into Motion (and like Fire that kindles other Matters, or Yeaft that ferments other Liquors, and moves them according to its own Laws) does propagate and maintain the Laws of the required Motions in other Subfances: Whereupon the Obfervation of Mr. Hartfoker, as relared by the faid Verbeyen, are
very remarkable; it appearing thereby, that this mov'd Matter in Semine Macculino, does preferve its Motion fome Hours in the Cold, but in the Heat it foon difappears. This feems better to agree with Particles that evaporate with Warmth, than with Animaloula, which ufually ftand in need of it, and are firft produced by Warmth; at leaft, if we fuppofe thefe Particles to be divefted of Animal Life, and to be only Matter put into Motion, this abfurd Confequence may be prevented, namely, that in the Semine Mafculino of every Creature, there muft be a Thoufand loft for one that comes to yoot.

Experience does likewife feem to confirm the faid Hypothefis (that from the Female preceeds the Matter, and from the Male the Particles that propagate the Laws of Motion therein) forafmuch as a Mule is produced from the Coicion of a Horfe and an Afs; and fo in orher Mixtures of different Species. The above-mention'd Mr. Verheyen, p. 71. may be confulted hereupon. But this may fuffice for Probabilities, fince, as far as I know, no Body has yet been able to give us an entire Decifion of this Matter.

> S ECT.X. Convictions from the foregoing Obfer- vations.

Only forafmuch as it is now found to be experimentally true in almoft all kinds of Plants and Living Creatures, that have been enquired into, that the former have their Origin in a Sied, and the latter in Stamina; but none from meer accidental Caufes, as Corruption and the like, I cannot upon this occafion forbear entreating the unhappy Atheift, if any Convictions will yet fatisfy him, that he would be pleafed ferioufly to reflect on all thefe things by himfelf, and then pronounce, whether mere Chance, or other Caufes ig-
norant of what they did, when they thus acted, could produce all thefe Stamina of Men (not to mention here the Seeds of Plants and Eggs of other Creatures) with fo much Art and in fo great a Number; and could infert and fold up all the Limbs and Joints of fuch a wonderful Machine, as is the Humane Body, in fo nice and accurate a manner, that the fame fhould be fill'd up and nourifhed by Juices, or (to ufe the common Technical Word) having expanded or unfolded it, would bring this Body into fuch a Difpofition and Stucture as is neceflary for fo many great Purpofes fur which it is formed.

The Atheif cannot be ignorant how many Learned Men have openly acknowledged in their Writings, the Almighty Power of the great Creator, upon enquiring into thefe his wonderful Works and Productions of Men, Beafts and Plants from fuch feeming inconfiderable and contemptible Stamina. Now then one of thefe two things mult be true; either that it is a certain and undeniable Demonflation of a God ; or that fo many famous Men, are utterly ignorant wherein the Strength of fuch a Proof confifts, and are therefore to be accounted compleat Vifionaries, if not mere Fools. This laft mult be aftereed by the Acheift concerning moft of the famous Undertakings of the late Age, or elfe he mult abondon his unhappy Principles: Let him therefore confider with himfelf, for what he himfelf muft pafs, with all Rational and Equitable Perfons.

## Sect. XI. Several Difficulties removed.

Now that a Stamen, which perhaps at firft contained nothing more than the Quantity of a little Grain of Sand, and perhaps lefs, can be unfolded or expanded to the Magnitude of a Humane Body think it impoffible, it feems proper and uffeful too, to remove chis Difficulty, by fhewing the poffibility thereof.
Let it therefore be fuppofed;
I. That the Divine Power can divide a determinate Quantity of Matter (for inftance, a little Grain of Sand, or any Thing lefs) into fo many Parts, and more than any Man can exprefs by a definite Number. No Body can deny this; and even an Atheift mult acknowledge, that in refpect to this Grain of Sand, fuch a Divifion or Separation of Parts does neither include a Contradiction, nor any Impoffibility in itfelf.
II. That a Foot being divided into ten Parts, each of thofe Parts may contain a Hundred Grains of Sand; which many other do admit with us.
III. That the Body of a Man which is Six Foot high, may be fuppofed to contain in it Six Cubical Feet; which, allowing for the Cavities therein, may be a pretty juft Calculation.
IV. Now fince roo Sands do compofe the tenth Part of a Foot in length, which we will here call an Inch, and there are ten fuch Inches in a Foor, a Thoutand Sands will go to the length of one Foot ; and confequently (fuppofing for conveni-ence-fake, the Sands to be fo many little Cubes $1,000,000,000$ or (to exprefs this Number with more Brevity, or the Unice with nine Cyphers) $10^{9}$ Sands do compofe one Cubical Foor, which being multiplied by Six, makes the whole number of Sands, that may be contained in a Humane Body
of Six Foot in length, amount to $6,000,000,000$, or $60^{\circ}$; from whence it appears, that in cafe fuch a Stamen, no bigger than a fmall Grain of Sand, were divided into $6,000,000,000$, of Parts, one Particle of the faid Sand might be placed in each fpace of a Sand in that Body.
V. Now to proceed further, fince it appears from the XXVI. Contemplation, 5 . '16. of Mr. Leuwenboek, that $\frac{10}{10} \frac{1}{0}$ of the length of a Sand, is the utmoft that can be diftinguifhed by a Microfcope ; to the end, that we may not take any Quantity that may be juftly fufpected of not being diftinctly vifible; let us take the $-\frac{2}{0} \frac{2}{0}$ of this length; fo then root of of Sand's length is incapable of being diftinctly viewed by any Microfcope. Since then there go $10^{18}$ of fuch Particles into the Compofition of one Sand, there will be 6027 of fuch little Cubical Spaces in a Humane Body of Six Foot in length ; but by reafon of their Smallnefs, they will be undiftinguifhable, even with the beft Microfcopes.

Now if we fuppofe that in each of thefe fmall Spaces, there be a Million of Parts in one Sand, there will go to the Compofition of the afore-mention'd Body $60^{33}$ of the like Particles of Sand.
VI. Now in cafe the Stamen of a Man, which we have fuppofed to be as big as a fingle Grain of Sand, were divided into fo many, or into $60^{33}$ Parts; its Parts may be fo difpofed and expanded, that in each fmall Space of a Humane Body of Six Foor in length (which Parts, by reafon of their Smallnefs, have not yet been able to be diftinguifhed by the finef Microfcope) there may be contained a Million of fuch Particles of Sand. And fince the Interftices between the Particles of the Stamen are yet fo much fmaller than the aforefaid little Spaces, they will be yet lefs vifible thro' a Microfcope, and confequently almoft invifible to the naked Eye; certainly in no manner diftinguint able.
VII. And thus it appears to be poffible, that fuch a fmall Stamen, no bigger than a Sand, may be expanded and brought to the Analogous Compofition of a Humane Body of Six Foot long; which Body, in its whole Matter, did not contain more than the quantity of this fingle Sand, yet in fuch a manuer, that there was not one vifible Place therein fo fmall, in which there were not contained more than a Million of Particles of this little Stamen: Between all which Particles, there were ftill remaining fo many Inrerftices or Vacuities, that this Body, which, by reafon of its Lightnefs, might be deemed little more than a Shadow, can be fo filled with flowing and adventitious Parts fixing themfelves in thefe Interftices, and Cloarhing as it were the Parts of this Stamen, that it at laft attains to the Weight and Size of a Common Body of a full grown Man.
VIII. And to the end, that no one may be furprifed at the fe minute Divifions of the quantity of a Grain of Sand, he will find in Profeflor Keil's Introduction, p. 55. fomething that may appear much more wonderful to him, of which however, the Poffibility is there demonftrated; viz. How not only a Body of Six Foot in length, but even that immenfurable Space, containing in its Circumference the Starry Heavens; or even a much larger, if you pleafe, may be filled and obfcured by the Duft of one fingle Grain of Sand, after fuch a manner, that not fo much as a Ray of Light, tho' never fo fine, Thall be able to pafs between the Parts of that Sand: Imagine then how far this furpaffes all that we have fuppofed to happen in a Humane Body.
IX. To prove this by a like Experiment, we fhall fhow in our Contemplation upon Ligbe, that a Particie of the Tallow of a Candle, not excecding the quintity of a fingle Grain of Sand, is reaily and actually divided into many more than the aforefaid $60^{33}$ Parts.

To demonftrate this very briefly here, you will find in the juft now mentiond Contemplation, that a Cubical Inch of Candle-Tallow, does emit or yield the Number of $269617040^{40}$ Parts of Light. Now, according to Numb. IV. here above, there are 1000,000 Sands in the quantity of fuch a $\mathrm{Cu}-$ bical Inch, and confequently there proceed from a Particle of Tallow, of the bignefs of one Sand, $269617040^{34}$ Parts of Light.

And according to Numb. VI. the Stamen that was likewife of the fize of a Sand, was fuppofed to be divided into $60^{33}$ Parts.

By which number of the like Particles, which proceed from the quantity of a Sand, or are divided into $269617040^{3^{4}}$ Parts, there will proceed 44936173 with a little Fraction. From whence it appears, that each little Particle of this Stamen, how fmall foever it may be (to take a round number) may be ftill divided into 44 , and very near 45 Millions of Parts; before each of them arrive to the Smallnefs of one of the Particles of Light, that continually flows frem a Burning-Candle.

Now that the fe exceeding fmall Particles are not unneceffary, on account of their Smallnefs, but are made ufe of to great Purpofes in the Univerfe, fhall be hereafrer Demonftrated in our 25 th Contemplation; as it is manifeft from thofe of Fire; which are found every where in the vifible World, and are made ufe of by the great Governour thereof, for fuch wonderful as well as terrible Ends.

And thus will it appear plain enough, as I think; that in fuch Expanfion and Divifion of this Stamen, we do not come near to that minutenefs, into which we fee experimentally that other Bodies in the World may be divided.

SECT. XII. Convictions from the foregoing Objervations.

We do not here pretend to determine the manner that God has been pleafed to make ufe of in the Expanfion of his Created Stamina; we mult leave that to his infinite Wifdom, whore Ways, herein efpecially, are infcrutable, or paft finding out; nor have we had any other view in what we have faid concerning it in the foregoing Section, than to convince the Atheifts, that they had a Maker, and to fet Things in a fomewhat clearer Light before the Eyes of fuch Chriftians that are not juft accuftom'd to compute thefe Matters after the manner of Machematical Propofitions; and therefore might find fomeDifficulty in expanding fuch a Small Stamen to the fimilar State of a full grown Body.

Let then an unhappy Philofopher, who will not yet confefs an All-ruling Go d, from what has been faid before; Let him, I fay, recire to fome folicary Place, and ferioully contemplate his own Body, and then judge, whether it could poffibly come to pafs without a wife Direction, that from fo fmali and tender a Stamen, expanded, filled, or ftuffed out and cloathed with other Matter, a Body fo wonderfully formed and adapted to fo many Ufes in all the Limbs and Parts, has been produced. What is there in a Watch, and in the adjufting of all its Wheels, Springs, ovc. that can be compared to the wonderful Formation of a Humane Body? And yer, was ever any Man fo Senfelefs, or, to fpeak in fofter Terms, fo deplorably Unhappy, that he fhould dare to maintaib, in the prefence of underitanding Perfons, that the Watch which he carries in his Pocket was framed in that manner, without any Wifdom or Defign?

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## S e c t. XIII. Tranfition to a Demonftration againft Cbance.

But as little as we know touching the manner of the Production of Humane kind; yet in what we daily fee thereof (tho' fcarce obferved by any) there is a very remarkable and ftrong Proof of a Divine Providence, adapting all Things to its wife Purpofes, and a plain Demonftration, that the World is by no means governed by Chance.

Before I propofe it, I find myfelf obliged to acquaint my Reader, that the Difcovery thereof is owing to the Ingenuity of Dr. Arbutbnot, a famous Marhematician, Member of the Royal Society, and Phyfician in Ordinary to the late Queen of England, who has been fo kind as to tranfmit it to me thro' the Hands of Mr. Burnet, the worthy Son of the late Bifhop of Salisbury, fo famous and fo well known to the Learned World; the which Mr. Burnet is likewife himfelf a great Mathematician, and Fellow of the faid Sociecy, and has allowed me the Honour to adorn this Treatife therewith.

Sect. XIV. A Table of the Number of Males and Females Cbrifters'd yearly in London in 82 Years.


In this Table it is remarkable :
I. That at London, in thefe 82 following Years, the number of Males has exceeded that of Females every Year.
II. That the Difference thereof has always lain between 2 Terms, nor far from one another. So that,
III. There were always more Males born than the half Children amounted to in one Year. And;
IV. That the Number of the Males never exceeded that of the Females fo far, that almoft all the Children fhould be Males.

Sect. XV. A Fudgment apon the Said Table.
Now, forafmuch as by Sea and Land-Fights, by other dangerous Occafions, and efpecially by a more irregular way of Life among the Men, a much greater number of them do daily Perifh than of the Women, by fuch Diftempers as are peculiar to them; can it be thought that it happens without a partictilar Direction of Providence, that there are conftantly more Men born than Women?

And (which is wonderful) that there are juft fo many more, that there ftill remains for every $W_{u-}$ man a Man of her own Age, in her own Country, and of equal Condition to her; This is confirmed by a perpetual Experience, to the Satisfaction of every one that makes ufe of his Reafon.

From whence Dr. Arbutbnot obferves, it feems a plain Confequence, that Poligamy, or the marrying of more Wives than one, is as oppofite to Nature, to the Government of the World, and the common Intereft of Mankind, as it is contrary to the partilar Laws of every Country; becaufe if one Man has feveral Wives, fo many other Men muft remain without them; befides that it fhould feem that many Women cannot be fo well impregnated by one, as each Woman by her own Husband.

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SEC T. XVI. The firft Mathematical Demonftration that the World is not governed by Cbance.

But to come finally to the chiefeft Proof that may be drawn from hence, againft an Accidental Caufe; fince Dr. Arbutbnot's Bufinefs would not allow him to follow this Table in all its Particulars, and from thence to form a Calculation (which, according to the common manner, would have required the continual Labour of feveral Months, as is well known to thofe that are vers'd in the Computation of the Games of Cbance or Hazard) he therefore fuppofes for Convenience-fake :
I. That if an equal number of Pieces of Money were thrown up into the Air, the Chance of their falling Crofs or Pile, as it is commonly called, would be equal; fo likewife among any equal number of fo many Children, there would be juit as many Males as Females born in the World, if thofe Births happen'd by meer Chance.
II. This Gentleman Thews, that if a Perfon (whom we fhall call $A$ ) fhould have laid the Wager $D$, that in toffing up fome thoufand pieces of Money, there would have fallen as many Crofs as Pile, the faid $A$ would have had a very finall Chance of winning his Wager $D$; and that the value of his Chance would have been much lefs than $\frac{1}{2}$ of $D$.
III. But becaufe the former Suppofition, that the Number of Males and Females is yearly equal, does too much leffen the Chance of $A$, that lays fuch a Wager; Dr. Arbuthnot does again advance that in order to make good fuch Diminution, the Chance of $A$ (which is otherwife fhewnto be of much lefs value than $\frac{1}{2}$ the Wager of $D$, every Year, or every Time) is now really fo much greater, and its value is compleatly $\frac{1}{z}$ of $D$.
IV. This being now laid down, if a Perfon (whofe Chance is $\frac{1}{2}$ of $D$ ) fhould wager that fuch a thing Thould happen 82 times to one; or rather, that there Should be as many Females as Males born every Year for 82 Years together; as he had wager'd before, that there fhould be fo in one Year ; they who underftand the Computations of Hazard or Chance, know that this Chance will be as $\frac{1}{2}$ eighty-two times multiplied into itfelf, and afterwards with $D$; or that there is fo great a Number (as is required when the double Number of 82 times multiplyed by itfelf, and the Unit fubftracted from it) againft One that the fame fhould not come to pafs by Chance after this manner, 82 times together: Which therefore makes a Number of 25 Numerical Figures following each other, the firft five whereof are 48357 ; as may be proved by the Logarithms with very little trouble. They that would know it more exactly, may compute it farther by the faid Logarithms; or elfe multiply the double Number 82 times by itfelf, and fubtract the Unir.

Now in cafe it is fo many againft one, that this Should not happen in London 82 Years together; let any one experienc'd in Calculations confider, how great a number there will be againft one, that the fame thing don't happen throughout the whole World, and fo often in 82 Years following; and then let him judge, whether it can be believed that Chance has any place here: For that this has really happen'd many Ages together, and in all Places of the World, may be maintained with great Probability, becaufe, that in all Times, and in all Places, the Men are expofed to more Dangers than the Women; and neverthelefs there will be found in all Countries Min for Women, and Women for Men, of equal Age and Condition.

SEC T. XVII. Tbe Difficulties and Objections that fome may make againft thefe Calculations anfover'd.

Thus far Dr. Arbutbnot, whofe brief Remarks upon what has happen'd, according to this Table, is fo ftrong a Proof of a wife Government of the World, that the fame ought fully to fatisfie every one who underftands this Calculation. But fince fome Atheifts, willing to evade the Force of this Argument, might ftart the following Objection; That Dr. Arbuthnot, to avoid trouble, fuppofes the Chance of one who lays a Wager, that fuch a thing Thould happen in one Year to be as $\frac{1}{2} D$; and that it does nor agree juft literally with the Table; let them know, that the fole Miftake that can be faid to be made therein, is only this; That thịs Gentleman allows too much to thofe that affert a Chance in thefe Matters, by fuppofing the Odds to be $\frac{1}{2} D$; and that therefore the Number, that according to his Hypothefis ftands againft One, is much fmaller than would be produced upon thefe Grounds by a more accurate Computation, in cafe he could have allowed the neceffary time for making it. This is obvious to all that underftand this Computation, fince, allowing his Adverfary the half of the Chances, he will win if there be only more Pieces of Money falling Crofs or Pile, or more Males than Females born, without any Limitation, when the Number of the Pieces, or of the Children is unequal; and in an equal number of Pieces, or of Children, the Adverfary would over and above have for himfelf the half of all thofe Chances which an equal Number of Crofs and Pile, or an equal Number of Males and Females, fhould give: Whereas, according to the Table (by reafon of the Limitations, between which the Majority of Males is really found) a great many Chances, in which there are more

Males than Females, would make them lofe; as alfo all the Chances which an equal Number of both would produce: Which does not want to be Demonftrated for fuch as are only experienced in the beginning of thefe Calculations. I thought it my Duty to add this, in order to clear the faid Calculation, which indeed is ftrong enough, but was however framed with a Defign of not fpending too much. Time upon it, from all the Objections of fuch as pretend to cavil at it.

And all that we have here faid, viz. that Dr. Arbuthnot, to avoid the Trouble and Time that fo nice a Calculation would have required, has granted his Adverfaries much more than was neceffary; may vifibly appear from the Calculation which that moft ingenious Mathematician Mr. 'Sgravefande (Profeffor of Mathematicks at Leyden) has been pleas'd, after a particular manner, to make upon it ; by which the ufual Method neceffarily required in the Difcuffion of this Matter, and in which a vaft deal of Pains and Time is taken up, is extreamly abridged.

Sect. XVIII. A Second, and more accurate Matbematical Demonfration, that the World is not govern'd by Cbance.

This Gentleman therefore refolving not to confine himefelf to any particular Hypothefis, and with a clofer view to the Numbers of the Table itfelf, in order to difcover that Number ftanding againft One, that what happen'd in London in the above-mention'd 82 Years, would not have happen'd, if it had been the meer refult of Fortuitious Caufes, adds up all the Children born in thofe 82 Years, in one Sum together, and finds that the 82d Part thereof amounts to 11429 ; which Number is therefore the Medium or Middle Number, which,
which, in cafe there were fo many born yearly, would again produce in 82 Years the fame Number of Children as the Table contains in its Total.
Finding moreover in the Table, that in the Year 1703 , the Difference berween Males and Females, in proportion to the Number of Children, was the fmalleft ; and that in the faid Year there were but 15448 born in all, of which 7765 were Males, and 7683 Females, he takes the middle Number to be 11429; and according to this Calculation he fuppofes there to be 5745 Males, and 5684 Females.

In like manner obferving, that in the Year 166 r the Difference between Males and Fermales was greateft, if calculated again according to the aforefaid middle Number 11429; the Males of that Year. will come out 6128, and the Females 53 아.

The firft Queftion then which is here to be anfwer'd, may be propofed after the following Manner:
$A$ wagers with $B$, that if 11429 Pieces of Money be thrown up in the Air, there will not fall down of 'ern fewer than 5745 Crofs, nor more than 6128 Pile: or thus; that among 1429 Children, born every Year according to this Medium, there will not be fewer Males than 5745, nor more Fe males than 6128 .
The Queftion then is, concerning the value of the Chance of $A$ ? or rather, how many Chances there be againft One, that what $A$ has wager'd fhall not come to pals, if all things depend on Fortune?
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SECT. XIX. The Calculation after the common Manner.

To return an Anfwer to this Queftion, let it be fuppofed that $C$ fignifies Crofs, and $P$ Pile, or Males and Females, then they who underftand che Modern Calculation of the Games of Hazard, know,
I. That the Binome C $P$, or $M F$, muft be raifed to the Power of which the Exponent is 11429 , or the faid Sum of 11429 muft be multiply'd by itfelf.
II. That all the Co-efficients or Genitures of the Ferms taken together, or the Power of the two Numbers, whereof 11429 is the Exponent, yield the quantity of all the Chances that can happen concerning the faid 11429 Pieces of Money. We will call the fame $p+q$.
III. That all the Co-efficients as well of both the Terms, in which we find $k^{6188} m^{5301}$, and $k^{5745}$ $m^{5684}$, as of all the Terms that are between thefe two, being added up together, make up the number of all the Chances which will caufe $A$ to win: We will call it $p$.
IV. That all the other poffible Chances, except thofe which caufe $A$ to win, are to the Advantage of $B$, and thefe we will call $q$.
$V$. Wherefore if $D$ be put in, that the value of the Chance of $A$, is $\frac{p}{p+q} D$, when $A$ has wager'd or laid that it Thall happen once, in the Money thrown up, or with the Children in one Year.
VI. and therefore the Chance of the Wager laid by $A$, that it Thall fo happen, againft that of $B$, who has laid the contrary (fuppofing it all meer Hazard) is as $p^{32}$ to $p \mp q^{82}-p^{82}$, or, to make ufe of the Unit, according as it is expreft in the former Queftion;

Queftion; as I to $\frac{p \mp q^{82}}{p^{22}}$ r, that is, as the Unit, to a Number which is found by dividing the quantity of all the poffible Chances $p \mp q$ by $p$; or by the quantity of all thofe that caufe $A$ to win, and fubftracting the Unit from this Quotient mulciply'd 82 times by itfelf.
$\mathrm{Se}_{\mathrm{E}} \mathrm{C}$. XX. This Tedious Calculation Contracted.
A luthis, as we have faid above, is well known to fuch as are vers'd in the Computations of the Chances of Games, but it is however very certain, that as fhort and eafie as the Solution of this Queftion appears to be in Words and Algebraical Letters,' yet the nimbleft Arithmetician, confidering the greatnefs of the Numbers that are to be found, would want fome Months to difpatch it, if he would exprefs it properly by Numbers, and would allo be fatisfied, that there were no Miftakes in his Calculation. Wherefore the aforemention'd Mr. 'Sgravefande, according to his vaft Experience and Skill in Mathematics, has remarkably abridged this Matter, and cut off the much larger Part of the tedious Work, which the common Method naturally requires, fhewing demonftratively, and with incomparably lefs Pains, that the Ratio of the Chance of $A$ to that of $B$, found in the foregoing Section, as $I$ to $\frac{p \mp g^{82}}{p^{82}}-1$ (notonly with the requifite Exactnefs, but even the caufing feveral very fmall Fractions, which would otherwife have been neglected, to tend to the Advantage of $A$, and thereby not to be liable to any Contradiction) I fay, that the faid Ratio may be expreft by the Ratio of the Unit to a Number, which
 ty two times by each other, and fubfracing the Unit,

Unit. So that with very little trouble, and by the help of Logaritbms, we may fee that there is a Chance of 44 Figures (of which the firft five are 75598) againft One, that what happen'd in London in the faid 82 Years, would not have happen'd, if it had been directed by Hazard only.

Mr. 'Sgravefande, who has computed the fame by Logarithmical Tables, finds it to be, 75, 598, 215, $229,552,469,135,802,469,135,802,469,469$, 135, 802, 469, againft One.

SECT. XXI. Convictions from the foregoing Calculations.

No w let every Man that can reprefent to hime felf the greatnefs of this Number, judge whether it is a wife Direction, or Fortune and Hazard only, that take place in this Matter; the rather, if he confiders how much greater this Number or Sum would be, if the fame Thing happen not only at London, but throughout the whole World, which, for the Reafons already alledg'd, is very probable.

This is certain; that fince this Sum is greater than all the Grains of Sand, which fome Millions of Globes, like that of the Earth, can contain, he that thinks it credible that what happen'd at Londons fell out by pure Chance, muft likewife maintain, that he thinks it as probable, that a Perfon deprived of his Sight and Feeling, and who has no manner of Rule for the Direction of his Hand, and therefore muft abandon himfelf entirely to Chance, fhould fingle one particular Grain of Sand out of fuch an unconceivable Heap jumbled all together, the very firft time he fhould put his Hand into it.

Now tho' Mr. 'Sgravefande has done me the Honour to fend me not only the proper Demonftrations, but likewife feveral and different ones after
$3^{62}$ The Religious Pbilofopher. an uncommon manner; yet I have paft them by here ; firft, becaufe they who are anywife vers'd in thefe kinds of Calculations, may find the common Manner briefly reprefented above; but if they don't underftand 'em, the Demonftrations that are futjoyn'd will not be able to give them any Light; and yet this Difcourfe would be fwell'd thereby to too great a Bulk: And, Secondly, becaufe that learned Gentleman's Method of Demonftrating and of Abridging, will Thortly be publifh'd with other of his Works, of which they who have Inclination and Ability may make a juft ufe.

In the mean while every one may from thence deduce a Proof of what has been advanc'd already, to put the Method ufed by Dr. Arbutbnot beyond Contradiction.

SECT. XXII. Expreffion of the Number found in Common Words.

Before I quit this Subject, fince there be among thefe Philofophers who afcribe all things to meer Chance, fome alfo that are not ufed to extend their Speculations to Arithmetic, or Numbers, and to whom the common Expreffions of Billions, Trillions, and the like are unintelligible, and confequently make no Impreffion on them; it may nor perhaps be unprofitable, in order to give them a more convincing Conception of the Number difcover'd by Mr. 'Sgravefande, §. XIX. to exprefs the Greatnefs thereof in fuch Words as every Body underftands.
For which Purpofe we know that when thisNumber of 54 Figures is divided by the Unit with 39 Noughts or Cyphers following ( $\$$. XIX.) there will remain a Dividend of 75598 , and a Fraction befijes. From whence it follows, that if we multiply a Number of a Hundred Thoufand times a. Hundred Tboufand

Millions, firft with a Hundred Tboufand times a Hundred Millions, we mutt take Ten Millions of this prodigious Number above Serenty five Tboufand, five Hundred and twenty eight times, before we can come at the Number or Odds againft One, that what happen'd at London in the aforefaid Eigbty swo Years, would not have fo happen'd, if the Birth of Males and Females were the refult of meer Chance only.

Now if fome fhould not be able to comprehend the foregoing Articles, as being foreign to their own Sudies, let them reflect upon the Greatnefs of this Number, as juft now expreft, and judge whether it is Credible, that in all this, Chance can be affign'd as the Caule of what is thus brought about, by any Man that ever made ufe of his Reafon and Difcretion.

## SECT. XXIII. No ignorant Laws of Nature bave anny place or fhare in the fe Matters.

Now I hope no Atheift will be fo defperately obftinate as, in order to quiet the Reproaches of his own Confcience (which muft convince him that Chance has no room here) to afcribe thefe Births, and all the Circumftances thereof to ignorant Laws of Nature: From whence he will pretend to argue, that fuch Births, tho even contrary to all the Rules of Chance, mult neceffarily happen after this, and no orher manner. For befides that all Laws, efpecially thofe to which fuch a variety of things muft be fubfervient, as in this cafe, before they can produce their Effects, do with great plainnefs lead us to a Law-giver, who has made and does keep up the fanze; fuppofe fuch a Philofopher were brought into a Shop where there were a great number of Clocks and Watches, all of which regularly perform'd their Functions; but that the faid Machines, confifted of two kinds, (as Humane Creatures
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Creatures do of two Sexes) one fort of which, for inftance, fhew'd the Day of the Month and fome other particular Movements; but the other, the Hour or Minutes only: Let him then tell us fincerely, whether he .would dare to maintain, tho' wholly ignorant by whom and how they were made, that both thefe kinds of Clocks, and each of thofe Movements were fram'd by a neceffary Law of Nature, without the Wifdom or Contrivance of an Artificer, that knew what he did, and fo acquired their ingenious Structure? And whether he thinks that he himfelf could pafs for a Man in his Senfes after forming fuch a Judgment? There is no need of making any Application which fo naturally follows of itfelf.

## The End of the Firft Volume.





[^0]:    * Now Doctor of Laws.

[^1]:    $\mathrm{C}_{4}$ (n) $\mathrm{SECT}_{\mathrm{t}}$

[^2]:    - An Engine ufed in driving Piles or Stakes into the Ground.

[^3]:    $7 \times$

[^4]:    Vel. I.

[^5]:    * Vid. Prop. 120. where one Machine keeps the Weight T in Equilibrium, and 100 Machines can do no more.

[^6]:    Now if
    Hammer $C$
    Drum whic
    at the fame
    by the Soun

[^7]:    SECT.

